FLORA OF SOUTHERN AFRICA

BRYOPHYTA

Editor O.A. Leistner

Part 1 Musci

Fascicle 3

Erpodiaceae — Hookeriaceae

by Robert E. Magill & Jacques van Rooy

NATIONAL
BOTANICAL
INSTITUTE

FLORA OF SOUTHERN AFRICA

which deals with the territories of

SOUTH AFRICA, LESOTHO, SWAZILAND, NAMIBIA AND BOTSWANA

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PART 1 MUSCI

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by

Robert E. Magill & Jacques van Rooy

with drawings by

Gillian Condy

Scientific editor: O.A. Leistner
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Alphabetical arrangement of taxa listed as 'published' in Plan of *Flora of southern Africa* A-4

NEW TAXA AND NEW COMBINATIONS PUBLISHED IN PART 1 FASCICLE 3

Distichophyllum mniifolium *(Hornsch.) Sim* var. **taylorii** *(Sim) Magill*, stat. nov., p. 614
Erpodium coronatum *(Hook. & Wils.) Mitt.* subsp. **transvaaliense** *(Broth. & Wager) Magill*, stat. nov., p. 453
Pterobryopsis acutifolium *(Brid.) Magill*, comb. nov., p. 569
Pterobryopsis hoehnelii *(C. Müll.) Magill*, comb. nov., p. 567
Ptychomitriopsis aloinoides *Magill*, sp. nov., p. 463

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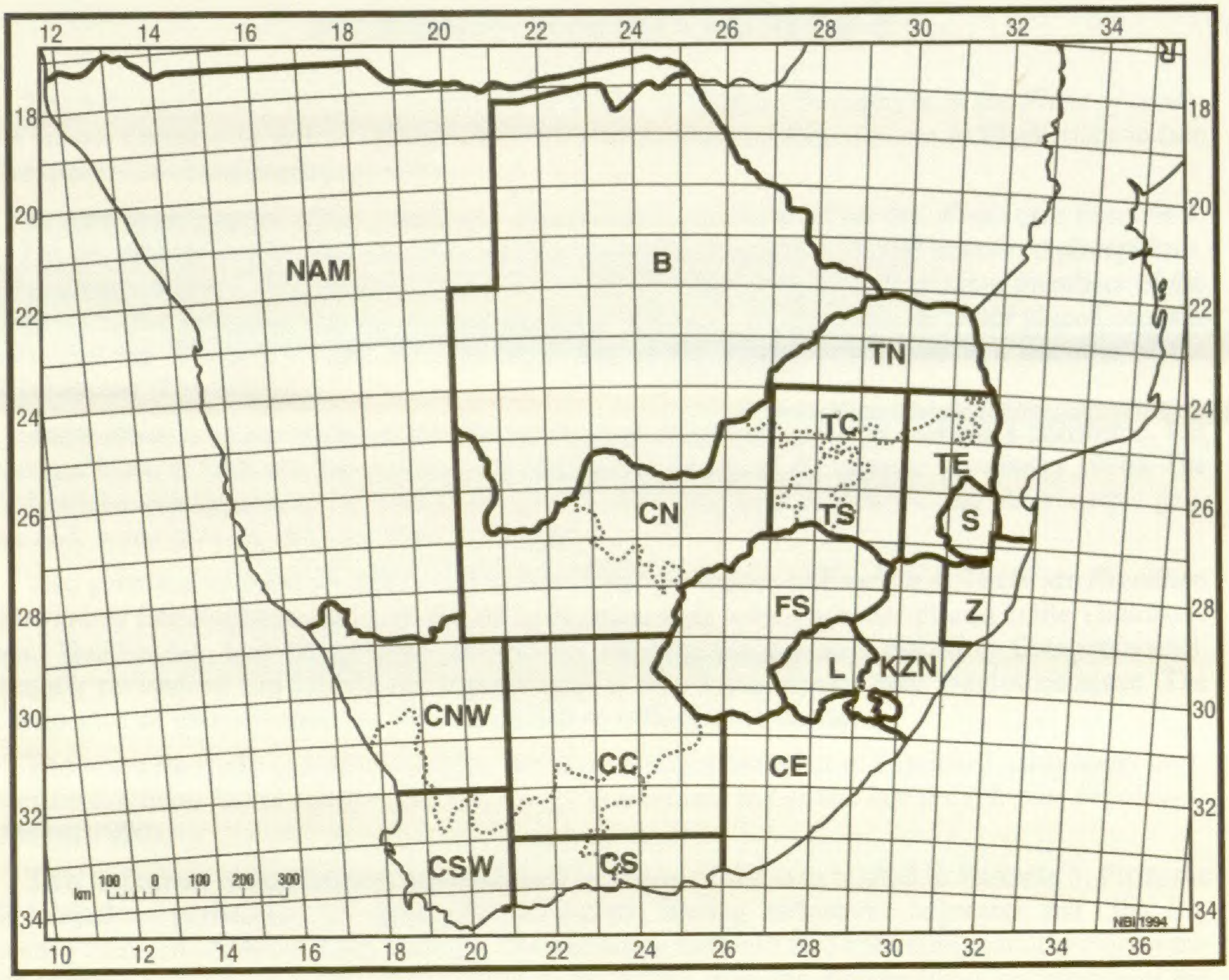


GEOGRAPHICAL REGIONS REFERRED TO IN THIS FASCICLE

B—Botswana
CC—central Cape
CE—eastern Cape
CN—northern Cape
CNW—northwestern Cape
CS—southern Cape
CSW—southwestern Cape
FS—Free State
KZN—KwaZulu-Natal
L—Lesotho
NAM—Namibia
S—Swaziland
TC—central Transvaal
TE—eastern Transvaal
TN—northern Transvaal
TS—southern Transvaal
Z—Zululand

INTRODUCTION TO FASCICLE 3

The following text constitutes Fascicle 3 of Part 1 of **Volume Bryophyta** in the *Flora of southern Africa* Cryptogam series. This fascicle includes the families Erpodiaceae to Hookeriaceae (see Conspectus of classification, p. 445).

Several inadequacies of the traditional classification system used for this *Flora* (see Fascicle 1, p. 13) are evident in this fascicle. The families treated in Fascicle 3 should contain diplolepidous, pleurocarpic mosses. Recent research on peristome development, including some members of the Orthotrichales, indicates that the Ptychomitriaceae (Edwards 1979) would be better placed near the Grimmiaceae (Fascicle 1) and that *Rhabdoweisia* of the Rhabdoweisiaceae is a member of the Dicranaceae (Fascicle 1).

Amphidium, a genus traditionally placed close to *Rhabdoweisia*, but lacking a peristome, has been included in Orthotrichaceae based on early development of the capsule (Lewinsky 1976). The Orthotrichaceae appears to be a transition group containing both acrocarpic and pleurocarpic genera and, when present, diplolepidous peristomes.

Two genera scheduled to appear in Fascicle 3 will be treated in Fascicle 4. These are *Rigodium* (previously Lembophyllaceae now placed in Rigodiaceae), which is better placed in the Thuidiales near Thuidiaceae, and *Catagonium* (previously Phyllogoniaceae now placed in Catagoniaceae), recently revised by Lin (1983) and repositioned in the Hypnobryales near Plagiotheciaceae. The Conspectus of classification has been modified to reflect these changes.

The notes on study and identification, and the Glossary included in Fascicle 1, also apply here. A more extensive list of terms used in bryology is available in *Glossarium polyglottum bryologiae* (Magill 1990).

Two important characteristics are exhibited by many of the taxa treated in Fascicle 3. First, the diplolepidous peristomes are generally incomplete, having endostome segments and cilia frequently reduced or occasionally lacking. The exostome teeth are also commonly modified in a variety of ways resulting in a peristome that is quite distinct from the diplolepidous peristomes of the Bryales treated in Fascicle 2 or those of the Thuidiales and Hypnobryales of Fascicle 4.

Second, many of the mosses treated here share a distinctive growth form. These plants have thin, creeping, primary stems growing appressed to the substrate. Secondary stems or branches arise more or less at right angles from these creeping stems. These innovations are said to be erect, a term used here to indicate an orientation perpendicular to the substrate or creeping stem. In some plants these secondary stems or branches become very long and pendent, forming large hanging masses from trees and rocks.

Some of the geographical regions referred to in the previous two fascicles (Magill 1981, 1987), partly demarcated by former provincial boundaries, have been changed in this fascicle to reflect recent constitutional developments in southern Africa. The former western Transvaal region now forms part of the northern Cape region, and the former Transkei region has been added to the eastern Cape region (see map on p. v). The name of the South West Africa/Namibia region has been changed to Namibia, that of the Orange Free State region to Free State, and that of Natal to KwaZulu-Natal. The name Zululand is retained for the northern part of KwaZulu-Natal Province. The 'Cape' and 'Transvaal' regions referred to in this fascicle no longer coincide with the former Cape and Transvaal provinces of South Africa.

The illustrations were prepared by Ms Gillian Condy; for technique and procedure, see Introduction to Fascicle 1, p. xv. Research on this fascicle was partly supported by grants to the Missouri Botanical Garden from the National Science Foundation and the National Geographic Society.

CONSPECTUS OF CLASSIFICATION

DIVISION BRYOPHYTA

Fascicle 1:

CLASS SPHAGNOPSIDA
ORDER SPHAGNALES
Family Sphagnaceae

CLASS ANDREAEOPSIDA
ORDER ANDREAEALES
Family Andreaeaceae

CLASS BRYOPSIDA
ORDER DICRANALES
Family Fissidentaceae
Nanobryaceae
Archidiaceae
Ditrichaceae
Seligeriaceae
Dicranaceae

ORDER POTTIALES
Family Calymperaceae
Encalyptaceae
Pottiaceae
Bryobartramiaceae
Grimmiaceae

Fascicle 2:

ORDER FUNARIALES
Family Gigaspermaceae
Ephemeraceae
Funariaceae
Splachnaceae

ORDER BRYALES
Family Bryaceae
Mniaceae
Eustichiaceae
Rhizogoniaceae
Aulacomniaceae
Bartramiaceae

Fascicle 3:

ORDER ORTHOTRICHALES
Family Erpodiaceae
Rhachitheciaceae
Ptychomitriaceae
Orthotrichaceae
Rhabdoweisiaceae
Racopilaceae

ORDER ISOBRYALES
Family Fontinalaceae
Wardiaceae
Hedwigiaceae
Cryphaeaceae
Leucodontaceae
Prionodontaceae
Trachypodaceae
Pterobryaceae
Meteoriaceae
Leptodontaceae
Neckeraceae
Thamnobryaceae

ORDER HOOKERIALES
Family Hookeriaceae

Fascicle 4:

ORDER THUIDIALES
Family Fabroniaceae
Leskeaceae
Thuidiaceae
Rigodiaceae

ORDER HYPNOBRYALES
Family Amblystegiaceae
Brachytheciaceae
Entodontaceae
Plagiotheciaceae
Catagoniaceae
Sematophyllaceae
Hypnaceae
Hylocomiaceae

CLASS POLYTRICHOPSIDA
ORDER POLYTRICHALES
Family Polytrichaceae

LITERATURE CITED IN FASCICLE 3

Literature references given outside formal literature treatments

ALLEN, B.H. 1983. On the costa of *Fontinalis* (Musci). *Lindbergia* 9: 37–40.

ALLEN, B.H. 1987. A systematic account of *Pulchrinodus inflatus* (Musci: Pterobryaceae), genus novum. *New Zealand Journal of Botany* 25: 335–342.

ALLEN, B.H. & CROSBY, M.R. 1986. Revision of the genus *Squamidium* (Musci: Meteoriaceae). *Journal of the Hattori Botanical Laboratory* 61: 423–476.

ANDERSON, L.E. & CRUM, H. 1959. Cytotaxonomic studies on mosses of the Canadian Rocky Mountains. *Bulletin of the National Museum of Canada* 160: 1–89.

ARZENI, C.B. 1954. The Pterobryaceae of the southern United States, Mexico, Central America, and the West Indies. *American Midland Naturalist* 52: 1–67.

BIZOT, M. & POCS, T. 1974. East African bryophytes. *Acta Academiae Paedagogicae Agriensis*, N. Ser. 12: 383–449.

BUCK, W.R. 1980. Animadversions on *Pterigynandrum* with special commentary on *Forsstroemia* and *Leptopterigynandrum*. *The Bryologist* 83: 451–465.

DE SLOOVER, J.L. 1983. Note de bryologie africaine XII.—*Porotrichum* et *Porothamnium*. *Bulletin du Jardin Botanique National de Belgique* 53: 97–152.

DIXON, H.N. 1920. New and interesting South African mosses. *Transactions of the Royal Society of South Africa* 8: 179–224.

DIXON, H.N. 1927. Studies in the bryology of New Zealand V. *New Zealand Institute, Bulletin* 3: 239–298.

DIXON, H.N. 1931. *Ptychomitriopsis* Dix. gen. nov. Ptychomitriacearum. *Journal of Botany, British and Foreign* 69: 284–285.

EDWARDS, S.R. 1979. *Taxonomic implications of cell patterns in haplolepidous moss peristomes*. In G.C.S. Clark & J.G. Duckett, *Bryophyte systematics*, Systematic Association Special Volume 14: 315–346. Systematics Association, London.

ENROTH, J. 1991. *Thamnobryum capense* comb. nov. (Neckeraceae, Musci). *Novon* 1: 110.

LEWINSKY, J. 1976. On the systematic position of *Amphidium* Schimp. *Lindbergia* 3: 227–231.

LEWINSKY, J. 1978. The genus *Orthotrichum* Hedw. (Musci) in Africa south of the Tropic of Cancer. *Botanisk Tidsskrift* 72: 61–85.

LEWINSKY, J. & VAN ROOY, J. 1990. New species and a new record of *Orthotrichum* from southern Africa: *O. incurvomarginatum* sp. nov., *O. armatum* sp. nov., *O. oreophilum* sp. nov. and *O. firmum* Vent. *Journal of Bryology* 16,1: 67–78.

LIN, S.-H. 1983. A taxonomic revision of Phyllogoniaceae (Bryopsida). Part 1. *Journal of Taiwan Museum* 36,2: 37–86.

MAGILL, R.E. 1981. *Flora of southern Africa*. Bryophyta 1,1: 1–291.

MAGILL, R.E. 1987. *Flora of southern Africa*. Bryophyta 1,2: 293–443.

MAGILL, R.E. (Ed.) 1990. *Glossarium polyglottum bryologiae: a multilingual glossary for bryology*. Monographs in Systematic Botany from the Missouri Botanical Garden 33, [x] + 297 pp. Missouri Botanical Garden, St Louis.

MAGILL, R.E. & SCHELPE, E.A. 1979. The bryophytes of southern Africa. An annotated checklist. *Memoirs of the Botanical Survey of South Africa* 43: 1–39.

MALTA, N. 1926. *Die Gattung* Zygodon *Hook. et Tayl. Eine monographische Studie*. RIGA.

MANUEL, M.G. 1973. Studies in Cryphaeaceae I. A revision of the genus *Cryphaea* in North America north of Mexico. *The Bryologist* 76: 144–162.

MANUEL, M.G. 1974. A revised classification of the Leucodontaceae and a revision of the subfamily Alsioideae. *The Bryologist* 77: 531–550.

MITTEN, G. 1869. Musci austro-americani. *Journal of the Linnean Society* 12: 1–659. Reprinted in: *Monographs in Systematics Botany from the Missouri Botanical Garden* 7 (1982).

MÜLLER, C. 1899. Contributiones ad Bryologiam austro–afram. *Hedwigia* 38: 52–155.

SHAW, J. 1986. Peristome structure in the Orthotrichaceae. *Journal of the Hattori Botanical Laboratory* 60: 119–136.

SIM, T.R. 1926. The bryophyta of South Africa. *Transactions of the Royal Society of South Africa* 15: 1–475.

SMITH, A.J.E. 1978. *The moss flora of Britain & Ireland*, 706 pp. Cambridge University Press, Cambridge.

STARK, L.R. 1987. A taxonomic monograph of *Forsstroemia* Lindb. (Bryopsida: Leptodontaceae). *Journal of the Hattori Botanical Laboratory* 63: 133–218.

TIXIER, P. 1989. Bryophyta exotica—8. Récoltes de J.-F. Brunel au Togo (1983–1985). *Candollea* 44: 493–511.

VAN ZANTEN, B.O. 1959. Trachypodaceae: a critical revision. *Blumea* 9: 477–575.

VITT, D.H. 1971. The infrageneric evolution, phylogeny, and taxonomy of the genus *Orthotrichum* (Musci) in North America. *Nova Hedwigia* 21: 683–711.

VITT, D.H. 1980a. The genus *Macrocoma* I. Typification of names and taxonomy of the species. *The Bryologist* 83,4: 405–436.

VITT, D.H. 1980b. The nomenclature and taxonomy of *Macrocoma lycopodioides* (Schwaegr.) Vitt. *Journal of Bryology* 11: 219–229.

VITT, D.H. 1980c. The genus *Macrocoma* II. Geographical variation in the *Macrocoma tenue-M. sullivantii* species complex. *The Bryologist* 83,4: 437–450.

WELCH, W.H. 1960. *A monograph of the Fontinalaceae*, [vii] + 357 pp. Martinus Nijhoff, The Hague.

WHITTEMORE, A. & ALLEN, B. 1989. The systematic position of *Adelothecium* Mitt. and the familial classification of the Hookeriales (Musci). *The Bryologist* 92: 261–272.

Abbreviations and full titles of books quoted in this work*

Bot. Taschenb. = Botanisches Taschenbuch
Bryo. S. Afr. = The Bryophyta of South Africa
Bryol. austr. excurs. = Bryologia austriaca excursoria
Bryol. Eur. = Bryologia europaea
Bryol. Univ. = Bryologia universa
Cat. Afr. Pl. = Catalogue of the African plants
Consp. regn. veg. = Conspectus regni vegetabilis
Coroll. bryol. eur. = Corollarium bryologiae europaeae
Engl. bot. = English botany
Enum. Bryin. exot. = Enumeratio Bryinearum exoticarum
Fl. bras. = Flora brasiliensis, Musci
Fl. nov. zel. = Flora novae-zelandiae
Hist. phys. Madagascar, mousses = Histoire physique, naturelle et politique de Madagascar
Horae phys. berol. = Horae physicae berolinenses
Icon. musc. = Icones muscorum
Index bryol. = Index bryologicus
Index bryol. suppl. = Index bryologicus supplementum
Index mus. pl. crypt. = Index musei plantarum cryptogamarum
Monograph Fontinalaceae = A monograph of the Fontinalaceae
Moss E.N. Amer. = Mosses of Eastern North America

* Abbreviations of journal titles follow Lawrence, G.H.M., Buchheim, A.F.G., Daniels, G.S. & Dolezal, H. (eds) 1968. *B-P-H, Botanico-Periodicum-Huntianum*. Hunt Botanical Library, Pittsburgh.

Moss Fl. Brit. Irel. = The Moss Flora of Britain and Ireland
Moss Fl. Fenn. = Moss Flora of Fennoscandia
Moss Fl. N. Amer. = Moss Flora of North America north of Mexico
Moss Fl. Pacific Northwest = Moss Flora of the Pacific Northwest
Moss. E. India = Mosses of Eastern India and adjacent regions
Moss. S. Austr. = Mosses of South Australia
Musc. Buitenzorg = Die Musci der Flora von Buitenzorg
Musc. frond. ined. archip. ind. = Musci frondosi inediti archipelagi indici
Muscol. brit. = Muscologia britannica
Muscol. recent. = Muscologia recentiorum
Muscol. recent. suppl. = Muscologia recentiorum supplementum
Muscol. recent. suppl. = Muscologia recentiorum supplementum seu species muscorum
N. Zeal. Mosses = A handbook of New Zealand mosses
Natürl. PflFam. = Die Natürlichen Pflanzenfamilien
Observ. bot. = Observationes botanicae
Prodr. aethéogam. = Prodrome des cinquième familles de l'Aethéogamie
Prodr. fl. bryol. Madagascar = Prodrome de la flore bryologique de Madagascar
Revis. gen. pl. = Revisio generum plantarum
Skand. Bladmossfl. = Skandinaviens Bladmossflora
Sp. musc. frond. = Species muscorum frondosorum
Sp. musc. frond. suppl. = Species muscorum frondosorum supplementum
Stud. handb. Brit. mosses = The student's handbook of British mosses
Syn. musc. eur. = Synopsis muscorum europaeorum
Syn. musc. frond. = Synopsis muscorum frondosorum omnium hucusque cognitorum
Syn. pl. = Synopsis plantarum
Tab. Calyptr. operc. = Tabula exhibens calyptratarum operculatarum

PROVISIONAL KEY TO THE FAMILIES OF FASCICLE 3

The following key is provided to allow access to the families treated in this fascicle. This key is a continuation of the family keys in Fascicles 1 and 2 and should be used in conjunction with them. Where necessary, couplets are incorporated into the key that refer to taxa that have been dealt with or will be treated in other fascicles.

1 Plants acrocarpic or appearing acrocarpic:
2 Calyptra cucullate:
3 Seta elongate; capsule long-exserted; gemmae occasionally present:
4 Gemmae present on stems and rhizomes . . . . . **ORTHOTRICHACEAE** (p. 476)
4 Gemmae not present on stems . . . . . (Fascicles 1 & 2)
3 Seta short; capsule immersed, emergent or short-exserted; gemmae absent:
5 Leaf cells papillose or striolate-papillose; peristome absent . . . . . **ORTHOTRICHACEAE** (p. 476)
5 Leaf cells smooth; peristome present:
6 Corticolous; perichaetial leaves long-sheathing, covering the seta; peristome teeth in 8 pairs . . . . . **RHACHITHECIACEAE** (p. 459)
6 Terricolous; perichaetial leaves scarcely differentiated; peristome teeth 16, fused at base, distant above, fugacious . . . . . **RHABDOWEISIACEAE** (p. 527)
2 Calyptra mitrate:
7 Leaves erect, appressed, contorted or crisped when dry, muticous, dull; lamina and margins generally unistratose; capsules immersed or short-exserted . . . . . **ORTHOTRICHACEAE** (p. 476)
7 Leaves incurled when dry, glossy; lamina or margins frequently bistratose; cells smooth or mammillose:
8 Leaves with long, hyaline awn, or if muticous then capsules immersed . . . . . **GRIMMIACEAE** (Fascicle 1)
8 Leaves muticous, capsules exserted . . . . . **PTYCHOMITRIACEAE** (p. 462)
1 Plants pleurocarpic or of pleurocarpic habit, stems and branches frequently erect from a creeping stem or rhizome:
9 Leaves ecostate or apparently so:
10 Plants aquatic or in splash zones:
11 Plants floating in streams, stems very long . . . . . **FONTINALACEAE** (p. 534)
11 Plants forming tufts on rocks in splash zone, stems shorter . . . . . **WARDIACEAE** (p. 538)
10 Plants of drier habitats, corticolous or saxicolous:
12 Plants large, branches ± erect; leaves widespreading when wet:
13 Leaf cells smooth, rhomboidal to elliptical . . . . . **LEUCODONTACEAE** (p. 553)
13 Leaf cells papillose or granulose, quadrate to rectangular or fusiform . . . . . **HEDWIGIACEAE** (p. 541)
12 Plants small, stems and branches appressed to substrate; leaves complanate; leaf cells hexagonal . . . . . **ERPODIACEAE** (p. 451)
9 Leaves costate:
14 Stems distinctly heterophyllous:
15 Stems creeping along substrate, dark green; leaf margins unbordered . . . . . **RACOPILACEAE** (p. 531)
15 Stems erect, green to glaucous green; leaf margins bordered by elongated cells . . . . . **HOOKERIACEAE** (p. 601)
14 Stems ± homophyllous:
16 Plants aquatic or in splash zones . . . . . **WARDIACEAE** (p. 538)

16 Plants of drier habitats:
17 Stems distinctly dendroid; leaf cells smooth:
18 Stems incurved when dry; leaf apices obtuse . . . . . **LEPTODONTACEAE** (p. 585)
18 Stems ± erect when dry; leaf apices acute to acuminate:
19 Leaves ± flat, leaf cells rhomboid, pitted . . . . . **THAMNOBRYACEAE** (p. 592)
19 Leaves noticeably concave with flattened apices:
20 Leaf cells elongate, walls pitted . . . . . **PTEROBRYACEAE** (p. 565)
20 Leaf cells rounded, walls smooth . . . . . **THAMNOBRYACEAE** (p. 592)
17 Stems erect, pendent or creeping, if branched, not distinctly dendroid; leaf cells smooth or papillose:
21 Stems and branches ± erect, perpendicular to substrate:
22 Alar cells not differentiated; costa single; calyptra mitrate, large, frequently covering the capsule; capsule exserted . . . . . **ORTHOTRICHACEAE** (p. 476)
22 Alar cells differentiated; costa absent, single or double; calyptra cucullate or conical and split up one side, not covering the capsule; capsule immersed or exserted:
23 Leaf cells papillose . . . . . **PRIONODONTACEAE** (p. 558)
23 Leaf cells smooth:
24 Costae double:
25 Leaf margins serrate; alar cells numerous, quadrate or transversely rectangular, green, walls smooth . . . . . **LEUCODONTACEAE** (p. 553)
25 Leaf margins entire; alar cells in small group, thickened, pitted . . . . . **PTEROBRYACEAE** (p. 565)
24 Costae single:
26 Erect stems unbranched; leaves squarrose . . . . . **PTEROBRYACEAE** (p. 565)
26 Erect stems irregularly branched; leaves erect to spreading:
27 Leaf margins ± entire; capsules exserted . . . . . **LEPTODONTACEAE** (p. 585)
27 Leaf margins serrate above; capsules immersed . . **CRYPHAEACEAE** (p. 550)
21 Stems and branches pendent or ± creeping along substrate:
28 Plants with long pendent stems and branches:
29 Leaf cells smooth:
30 Branch leaves spirally ranked . . . . . **PTEROBRYACEAE** (p. 565)
30 Branch leaves not in distinct rows . . . . . **METEORIACEAE** (p. 575)
29 Leaf cells papillose:
31 Papillae seriate, or if papillae single then leaf margins strongly serrate . . . . . **TRACHYPODACEAE** (p. 560)
31 Papillae numerous, scattered over cell lumens, or if papillae single then leaf margins serrulate . . . . . **METEORIACEAE** (p. 575)
28 Plants creeping over substrate:
32 Leaf cells papillose . . . . . **ORTHOTRICHACEAE** (p. 476)
32 Leaf cells smooth:
33 Leaf margins distinctly bordered by elongated cells . . . **HOOKERIACEAE** (p. 601)
33 Leaf margins not bordered:
34 Leaves complanate and undulate; capsules immersed . . . . . **NECKERACEAE** (p. 590)
34 Leaves appressed or spreading, flat; capsules exserted:
35 Costae strong and double, to midleaf or above . . . **HOOKERIACEAE** (p. 601)
35 Costae single:
36 Stems heterophyllous; leaves with short awn . . . . **RACOPILACEAE** (p. 531)
36 Stems homophyllous; leaves muticous . . . . **ORTHOTRICHACEAE** (p. 476)

ERPODIACEAE

Plants small, stringy, in loose wefts; corticolous or saxicolous. *Stems* branched; central strand weak or absent; paraphyllia and pseudoparaphyllia absent. *Leaves* crowded or somewhat distant, concave, clasping the stem or erect, ovate to elliptical, apex acute to rounded, muticous or with long hyaline awn. *Laminal cells* uniform, quadrate to rectangular, smooth or papillose, weakly thickened, alar cells not differentiated.

Autoicous. *Perichaetia* on short branches. *Seta* short or absent. *Capsule* immersed or just emergent, cylindrical. *Peristome* absent or rudimentary. *Operculum* convex, beaked. *Calyptra* campanulate, sometimes twisted and clasping the seta, ribbed, naked. *Spores* large, granulate.

A family of five genera found in temperate regions of the world; two genera are represented in southern Africa in dry woodland situations.

These tiny plants generally grow as scattered stems or loose groups on the bark of trees or rocks. Macroscopically the plants resemble some leafy liverworts and can be easily overlooked.

Leaves uniform in size and shape; capsule immersed to emergent; calyptra not twisted . . . . . 1. **Erpodium**
Leaves dimorphic, those facing substrate narrower and somewhat smaller; capsule exserted; calyptra spirally twisted . . . . . 2. **Aulacopilum**

1. ERPODIUM

Erpodium *(Brid.) C. Müll.* in Bot. Zeitung (Berlin) 1: 774 (1843); Broth. in Natürl. PflFam., edn 2, 11: 2 (1925); Sim, Bryo. S. Afr. 347 (1926); Crum in Nova Hedwigia 23: 205 (1972). Type species: *E. domingense* (Spreng.) C. Müll.

Plants small, slender; terricolous or saxicolous. *Stems* creeping, branched; central strand small or absent. *Leaves* crowded, appressed and flattened against stem, ovate to elliptical, muticous or awned; ecostate. *Laminal cells* small, isodiametric, smooth or papillose, walls weakly thickened.

Autoicous. *Perigonia* on branches, gemmate. *Perichaetia* on short branches along stem, obvious; perichaetial leaves sheathing. *Capsule* immersed or emergent; annulus frequently well developed. *Peristome* absent or rudimentary. *Calyptra* campanulate or mitrate, ribbed. *Spores* large, granulate.

A genus of 17 species, *Erpodium* is known from temperate and subtropical regions primarily in the southern hemisphere. Four species are recognized in the *Flora* area.

1 Leaves with hyaline awn:
  2 Leaf cells papillose . . . . . 1. *E. beccarii*
  2 Leaf cells smooth . . . . . 2. *E. coronatum* subsp. *transvaaliense*
1 Leaves muticous:
  3 Leaves broad, elliptical to orbicular; apex obtuse to rounded, cuspidate . . . . . 3. *E. grossirete*
  3 Leaves ovate to ovate-lanceolate; apex acute to obtuse . . . . . 4. *E. distichum*

1. **Erpodium beccarii** *C. Müll.* in Nuovo Giorn. Bot. Ital. 4: 18 (1872); Crum in Nova Hedwigia 23: 211 (1972). Type: Bogos, Abyssinia. *O. Beccari s.n.*

Aulacopilum beccarii (C. Müll.) Mitt. in J. Linn. Soc., Bot. 13: 308 (1873).

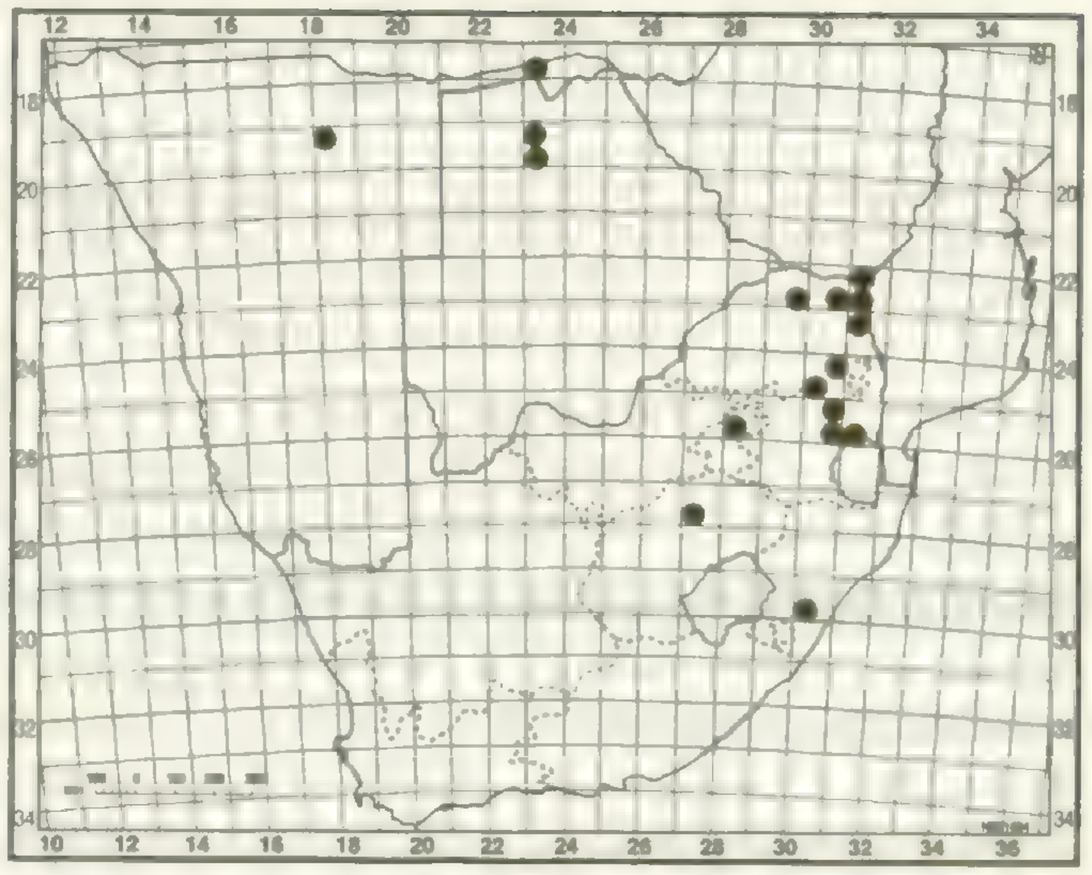
Erpodium hanningtonii Mitt. in J. Linn. Soc., Bot. 22: 313 (1886); Sim, Bryo. S. Afr. 347 (1926).

Erpodium joannis-meyeri C. Müll. in Flora 73: 486 (1890).

Erpodium menyharthii C. Müll. in Verh. Zool. Bot. Ges. Wien. 43: 13, 14 (1893).

Plants small and slender, creeping or in wefts, dark green to grey-green; corticolous. *Stems* to 20 mm long, branches few, scattered. *Leaves* evenly spaced, erect-spreading wet, appressed dry; broadly ovate to elliptical, 1.0–1.2 mm long; obtuse; awns hyaline, papillose, to 0.5 mm long; rounded at base; margins plane, entire; ecostate. *Upper laminal cells* hexagonal to subhexagonal, 10–18 µm long, walls weakly thickened, homogeneous, papillose on both surfaces, papillae C-shaped, centred over lumen; basal cells not strongly differentiated, quadrate to rectangular, 25–37 µm long; alar cells not strongly differentiated, transversely rectangular, hyaline, walls thin.

Perigonial leaves ovate-acute, 0.3–0.4 mm long. *Perichaetia* strongly differentiated, hyaline; perichaetial leaves with base sheathing, ovate-acuminate, 1.5–1.8 mm long, leaf cells irregularly rectangular to quadrate at margins, elongate fusiform to rhomboidal, alar cells quadrate, not well defined. *Seta* 0.1–0.3 mm long, brown, smooth. *Capsule* immersed, erect, short-cylindrical to broadly ovoid, 1 mm long, smooth, yellow-brown, gymnostomous; exothecial cells rectangular, walls thin, cells at mouth not differentiated, annulus persistent, thick-walled, in 3 or 4 rows, neck cells not differentiated; stomata on lower urn, phaneropore. *Operculum* convex-rostrate, beak curved or bent. *Calyptra* campanulate, lobed and ribbed, serrate on ribs. *Spores* rounded, 30–40 µm, weakly papillose, brown. Fig. 126: 12–18.



MAP 177.—**Erpodium beccarii**

Found on bark in woodlands of Central America, temperate South America, and eastern and southern Africa and Madagascar. *Erpodium beccarii* is rarely collected in Namibia, KwaZulu-Natal, Botswana and the Free State, but is more common in woodland communities of the Transvaal regions and Zimbabwe. Map 177.

Vouchers: *Magill 3631, 4957, 5025; Vahrmeijer 121B, 13151.*

This species is most easily identified by its long, hyaline awns that strongly contrast with the dark green colour of the leaves. The papillose cells of the awn and leaf lamina separate this species from *E. coronatum* subsp. *transvaaliense*.

2. **Erpodium coronatum** *(Hook. & Wilson) Mitt.* subsp. **transvaaliense** *(Broth. & Wager)*

FIG. 126.—**Erpodium coronatum** subsp. **transvaaliense** (1–11): **1.** habit (dry), × 1; **2.** habit (wet), × 10; **3.** stem in cross section, × 175; **4.** leaf, × 35; **5.** basal leaf cells, × 122; **6.** upper laminal cells, × 245; **7.** cells at leaf apex, × 122; **8.** capsule with attached perichaetial leaf, × 25; **9.** part of capsule mouth showing persistent annulus and peristome, × 175; **10.** calyptra, × 50; **11.** spore, × 495. **E. beccarii** (12–18): **12.** habit (dry), × 1; **13.** habit (wet), × 10; **14.** leaf, × 35; **15.** upper laminal cells, × 245; **16.** perichaetial leaf, × 25; **17.** part of capsule mouth showing exothecial cells and capsule mouth, × 175; **18.** spore, × 495. **E. grossirete** (19–24): **19.** habit (dry), × 1; **20.** habit (wet), × 10; **21.** leaf, × 35; **22.** upper laminal cells, × 245; **23.** leaf apex, × 122; **24.** perichaetial leaf, × 35. (1–3, 8 & 9, *Smook 3181*; 4–7, 10 & 11, *Magill 3039*; 12, *Magill 4958*; 13, *Magill 3629*; 14 & 15, *Magill 3633*; 16–18, *Van Vuuren 1703*; 19–24, *Vahrmeijer 121a*.)

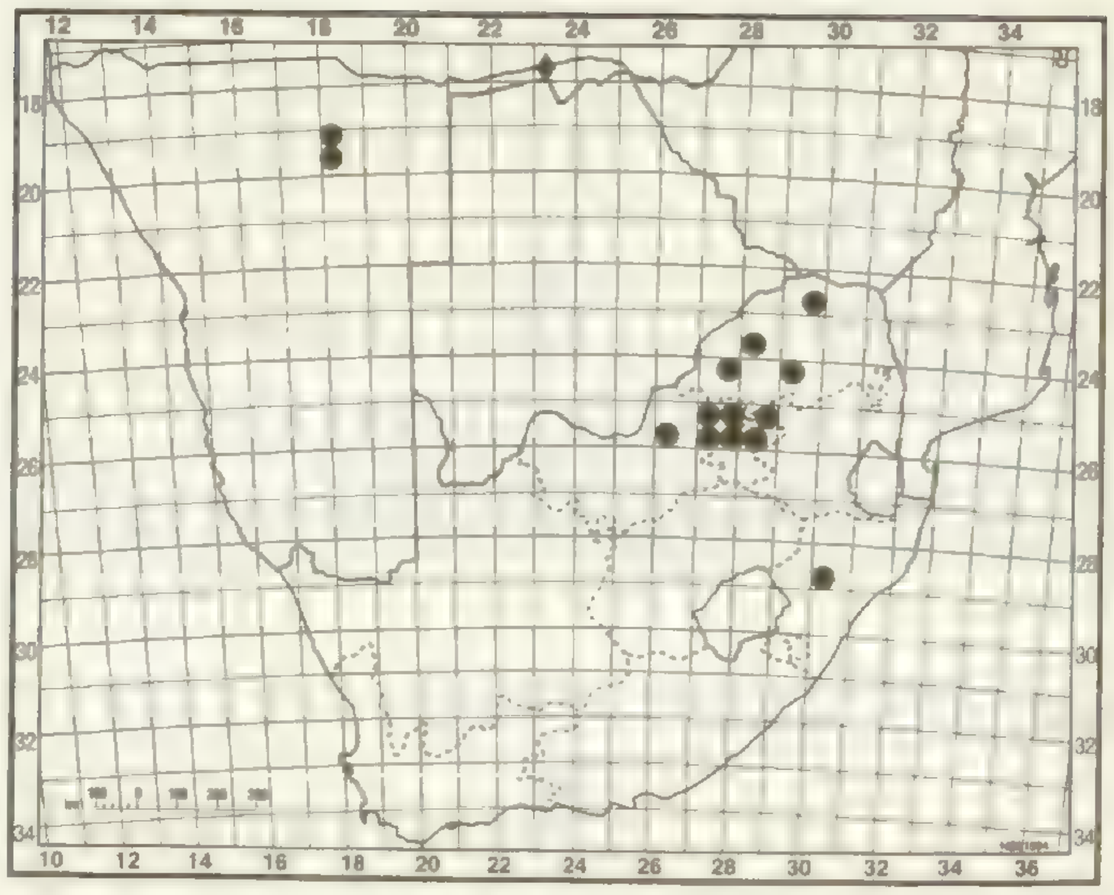
Magill, stat. nov. Type: Transvaal, Wolhuter, *Wager 189* (BM, holo.; PRE, GRA, iso.).

Erpodium transvaaliense Broth. & Wager in Dix. in Trans. Roy. Soc. South Africa 8: 208 (1920); Broth. in Natürl. PflFam., edn 2, 11: 3 (1925); Sim, Bryo. S. Afr. 347 (1926).

Plants small, creeping or in wefts, dark green to brownish green; corticolous. *Stems* 10–20 mm long, branches few, scattered; in section round, central strand small, inner cortical cells thick-walled, hyaline, in 2 or 3 rows, outer cortical cells thick-walled, brown, in 2 rows. *Leaves* crowded, erect-spreading wet, appressed dry; ovate to oblong, 0.8–1.2 mm long; acute to acuminate, aristate, awns hyaline, smooth, length variable; rounded at base; margins plane, entire; ecostate. *Upper laminal cells* irregular, walls thickened, homogeneous, smooth on both surfaces; basal cells not strongly differentiated, walls thin, papillae scattered, hyaline-green, walls thin; alar cells not differentiated.

Perichaetia green; leaves sheathing below, oblong-cuspidate, 1.8–2.0 mm long, leaf cells quadrate to rectangular at margins, elongate to rhomboidal at centre of leaf, alar cells quadrate, not well defined. *Seta* 1 mm long, yellow, smooth. *Capsule* immersed, erect, broadly ovoid, 1.8 mm long, smooth, yellow to brown; exothecial cells rectangular, walls thin, wavy, cells at mouth not differentiated; annulus persistent, well developed, thick-walled, 3 or 4 rows high; neck cells not differentiated; stomata on lower urn, phaneropore. *Peristome* single, hyaline; exostome teeth irregular, erect, papillose, 150 µm high. *Operculum* convex, long-rostrate, 0.5 mm long. *Calyptra* mitrate, lobed and ribbed, 1 mm long, naked. *Spores* rounded, 35–40 µm, weakly papillose, light brown. Fig. 126: 1–11.

Endemic to southern Africa, *E. coronatum* subsp. *transvaaliense* is the most commonly collected *Erpodium* in the *Flora* area. The plants are very small and difficult to locate in crevices of tree bark in the northern and central Transvaal regions, northern Cape area, KwaZulu-Natal and northern Namibia. Map 178.



MAP 178.— ● **Erpodium coronatum** subsp. **transvaaliense**
♦ **Erpodium grossirete**

Vouchers: *Magill 3039, 3646, 6391; Perold 115; Smook 1822.*

The long, smooth, hyaline hairpoint and smooth leaf cells separate this taxon from the other southern African species. It differs from the more widespread *E. coronatum* (Hook. & Wils.) Mitt. in its well developed awn and weakly ribbed calyptra. Although locally distinct, this taxon is best treated as a subspecies of *E. coronatum*.

3. **Erpodium grossirete** *C. Müll.* in Verh. Zool. Bot. Ges. Wien 43: 13 (1893); Broth. in Natürl. PflFam., edn 2, 11: 3 (1925). Type: Zambesia, Boroma, *Menyharth s.n.*, Aug. 1890.

Plants small, creeping, compact, dark green; corticolous. *Stems* julaceous, 10 mm long, branching irregular, ± dense and erect from creeping stem; in section round, central strand absent, inner cortical cells thin-walled, hyaline, in 3 rows, outer cortical cells weakly thickened, in single row. *Leaves* ± crowded, erect-appressed wet, appressed dry, weakly concave; stem leaves broadly elliptical to ± orbicular, 0.6–1.0 mm long; obtuse to rounded or truncate, mucronate to cuspidate; abruptly rounded at base; margins plane, entire, bordered; ecostate. *Upper laminal cells* irregularly quadrate to transversely hexagonal, 12–25 µm long, 12–31

µm wide, walls ± thickened, homogeneous, smooth on both surfaces; basal cells similar to upper cells, 12–25 µm long, 15–31 µm wide, hyaline, smooth; alar cells similar to basal cells but more strongly transversely rectangular, hyaline-green, walls thin.

Perigonial leaves ovate-acute. *Perichaetia* green but quickly becoming hyaline; perichaetial leaves oblong-acuminate, strongly sheathing, 2.0 mm long, leaf cells rectangular-oblong or fusiform, shorter at margins, somewhat thickened, basal and alar cells not well defined. *Seta* very short. *Capsule* immersed, erect, cylindrical, 1.0–1.6 mm long, smooth, yellow, gymnostomous; exothecial cells ± irregular, walls thin, cells at mouth not differentiated; annulus persistent, thick-walled, in 1 or 2 rows; neck cells not differentiated; stomata not seen. *Operculum* and *calyptra* not seen. *Spores* rounded, 37 µm, granulate, brownish. Fig. 126: 19–24.

Endemic to southern Africa, *E. grossirete* is rarely collected from bark of trees along streams and in swamp forests in Malawi, northeastern Zimbabwe, Mozambique and the eastern Caprivi Strip of Namibia. Map 178.

Vouchers: *Magadza 162; Vahrmeijer 121A.*

Sim (1926) was incorrect in his interpretation of this species; all the specimens Sim examined were *E. distichum*. These two species can be easily separated on the basis of plant habit, leaf shape, and leaf cell shape and size, although the two species are similar in many sporophytic characteristics. The rather large cylindrical capsules and very short setae clearly separate these two species into a distinct group within the genus.

4. **Erpodium distichum** *Wager & Dix.* in Trans. Roy. Soc. South Africa 8: 208 (1920); Broth. in Natürl. PflFam., edn 2, 11: 3 (1925). Syntypes: Transvaal, Barberton, *Wager 279*; Natal, Pietermaritzburg, *Wager 226.*

Plants small, slender, creeping, dark green; corticolous. *Stems* up to 10 mm long, branches few, scattered; in section round, central strand absent, inner cortical cells thin-walled, hyaline, in 3 rows, outer cortical cells hyaline, in single row. *Leaves* evenly spaced, erect-spreading wet, appressed dry; ovate to ovate-lanceolate, 0.8–1.2 mm long; acute to obtuse; weakly rounded at base; margins plane, entire; ecostate. *Upper laminal cells* hexagonal-fusiform, marginal cells smaller, transversely rectangular, 25–41 µm long, 12–18 µm wide, walls thin to slightly thickened at corners, homogeneous, smooth on both surfaces; basal cells rectangular centrally, transversely rectangular at margins, 12–15 µm long, 30–40 µm wide, hyaline; alar cells quadrate to transversely rectangular, 12 × 18 µm, hyaline-green, walls thin.

Perichaetia obvious, green; perichaetial leaves oblong-acute, sheathing 1.5–1.8 mm long, leaf cells not strongly differentiated from vegetative leaf cells. *Seta* very short. *Capsule*

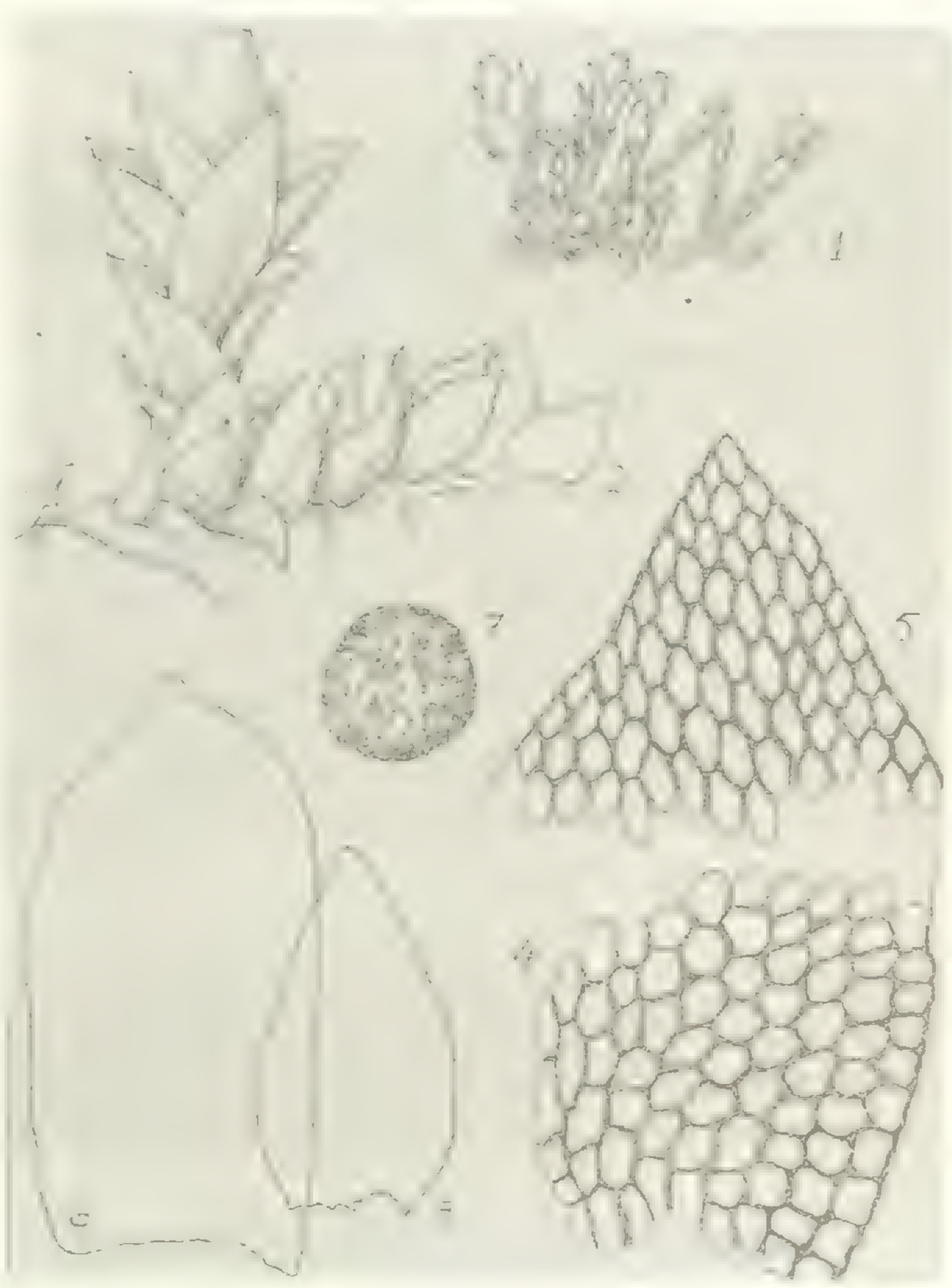
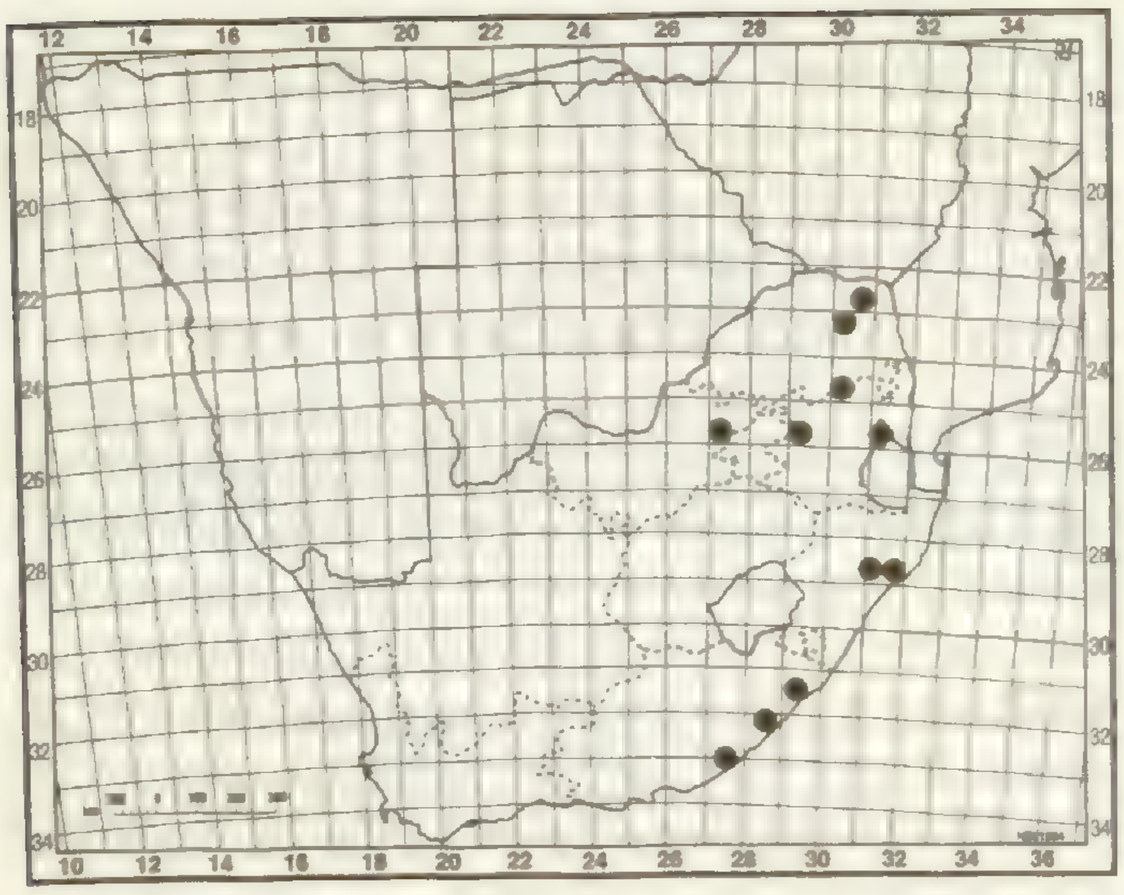


FIG. 127.—**Erpodium distichum**: **1.** habit (dry), × 5; **2.** habit (wet), × 15; **3.** leaf, × 35; **4.** basal leaf cells (right side), × 175; **5.** leaf apex, × 175; **6.** perichaetial leaf, × 35; **7.** spore, × 495. (1, *Wager PRE-CH 11717*; 2, *Wager PRE-CH 11944;* 3–7, *Wager PRE-CH 1059.*)



MAP 179.— ● **Aulacopilum trichophyllum**
♦ **Erpodium distichum**

erect, cylindrical, 1.5 mm long, smooth; exothecial cells shortly rectangular, walls thin, cells at mouth smaller, quadrate, in 3 or 4 rows; annulus absent; neck cells not differentiated; stomata not seen; gymnostomous. *Operculum* and *calyptra* not seen. *Spores* rounded, 35–38 µm, granulate, light brown. Fig. 127.

Endemic to southern Africa, *E. distichum* is rarely collected on trees in Zimbabwe, Mozambique and the eastern Transvaal region. No recent specimens have been seen and all the South African specimens appear to be from a single large collection made by Wager at Barberton in 1914, although 'Maritzburg' is also cited on one of the syntypes. Map 179.

Vouchers: *Eyles 2702; Sim 8988.*

An unusual, narrow-leaved, muticous species that is distinct gametophytically from the other southern African species. The extremely short seta clearly indicates a relationship to *E. grossirete* (see p. 454). It is unclear why the species has not been recollected, unless it is restricted to a very small area of the eastern Transvaal region.

2. AULACOPILUM

Aulacopilum *Wilson* in London J. Bot. 7: 90 (1848); Broth. in Natürl. PflFam., edn 2, 11: 4 (1925); Sim, Bryo. S. Afr. 346 (1926); Crum in Nova Hedwigia 23: 218 (1972). Type species: *A. glaucum* Wilson.

Plants small, slender; corticolous or saxicolous. *Stems* creeping, branched; central strand absent. *Leaves* weakly concave, appressed, elliptical to ovate; apiculate or with short or long hyaline awn; ecostate. *Laminal cells* isodiametric, multipapillose, walls weakly thickened.

Autoicous. *Perigonia* on stem, gemmate. *Perichaetia* on short branches; perichaetial leaves sheathing. *Capsule* exserted, annulus not strongly differentiated. *Peristome* absent. *Calyptra* spirally twisted, ribbed, clasping seta. *Spores* large, granulate.

Gametophytically *Aulacopilum* is similar in many respects to *Erpodium*; however, the dimorphic leaves, (those facing the substrate are smaller and narrower) and the twisted calyptra are important differences. The operculum remains attached to the columella and is retained by the twisted and clasping calyptra, thus retarding spore discharge.

Aulacopilum trichophyllum *Ångstr.* in *C. Müll.* in Bot. Zeitung (Berlin) 20: 393 (1862); Sim, Bryo. S. Afr. 346 (1926). Type: South Africa, *Wahlberg s.n.*

Aulacopilum incanum Mitt. in J. Linn. Soc., Bot. 13: 308 (1873).

Plants small, slender, in wefts, creeping, dark green or sometimes glaucous; saxicolous or corticolous. *Stems* flattened, up to 10 mm long, branching ± regular; in section round, central strand absent, inner cortical cells large, thin-walled, hyaline, outer cortical cells smaller,

thick-walled, yellow. *Leaves* dimorphic, evenly spaced, ± appressed wet, appressed dry; upper leaves elliptical to ovate, 0.6–1.0 mm long; acute, apiculate or short-awned; rounded at base; margins plane, entire, ecostate; lower leaves somewhat smaller and narrowly ovate-acuminate. *Upper laminal cells* rounded hexagonal, 12–16 µm long, walls weakly thickened, homogeneous, papillose on both surfaces, papillae dense, centred over lumens; basal cells rectangular only at central part of insertion, 12–16 µm long, 2–4 µm wide, hyaline; alar cells not forming distinct groups.

Perigonial leaves ovate-cuspidate, 0.4 mm long. *Perichaetia* green; perichaetial leaves oblong-acuminate, sheathing, larger than stem leaves but not strongly differentiated, 1.0–1.2 mm long, leaf cells rectangular to rhombic. *Seta* up to 1 mm long, yellowish, smooth. *Capsule* exserted, erect, short-cylindrical, 0.5 mm long, smooth, yellow-brown; exothecial cells quadrate to rectangular, walls weakly thickened, cells at mouth transversely rectangular in 1 or 2 rows; annulus weakly differentiated; stomata on neck, phaneropore; gymnostomous. *Operculum* convex-rostrate, cells not twisted. *Calyptra* mitrate, large, completely covering capsule and clasping seta, up to 1 mm long, twisted and slit down one side, plicate, naked. *Spores* rounded, 22–26 µm, granulate, yellow-brown. Fig. 128.

These plants grow on trees or boulders in the northern, eastern and central Transvaal areas, Zululand and the eastern Cape region. The species has also been reported from Uganda, Malawi and Zimbabwe. The small, loose patches of dark green threads are easily overlooked in open woodland and coastal forest habitats. Map 179.

Vouchers: *Linder 1232; Magill 4982, 6368; Oliver 7354; Smook 1466; Wager 319.*

FIG. 128.—**Aulacopilum trichophyllum**: **1.** habit (dry). × 3; **2.** habit (wet), × 5; **3.** stem in cross section, × 350; **4.** dimorphic leaves, × 70; **5.** basal leaf cells (left side), × 175; **6.** upper laminal cells at right margin, × 700; **7.** leaf apex, × 175; **8.** perichaetial leaf, × 70; **9.** habit showing capsule with operculum, × 25; **10.** calyptra, × 35; **11.** spore, × 700. (1 & 2, *Magill 4982*; 3–5, 8, 11 & 12, *Junod 12*; 6, 7, 9 & 10, *Magill 3210*.)

The southern African plants are generally dark green and do not exhibit the strong glaucous coloration of the Australian species *A. glaucum* to which they are most closely related. They also have a much stronger awn than the Australian species.

RHACHITHECIACEAE

Plants minute to small, gregarious or caespitose, yellowish green; corticolous. *Stems* erect, central strand of hydroids present. *Leaves* larger above, erect-incurved when dry, erect-spreading when wet, oblong-spathulate; costa ending well below apex. *Cells* irregularly hexagonal, rectangular below, thin-walled, smooth. *Gemmae* oblong, axillary.

Autoicous. *Perigonia* gemmate. *Perichaetia* terminal; leaves long, sheathing, covering seta. *Seta* thick, straight or curved above, vaginula long. *Capsule* erect to inclined, ovate-cylindrical, strongly 8-ribbed; stomata phaneropore; annulus revolvable. *Peristome* single, teeth in 8 pairs, trabeculate, smooth. *Operculum* conic-apiculate, oblique. *Calyptra* cucullate, widely split. *Spores* rounded to elliptical.

RHACHITHECIUM

Rhachithecium *Broth. ex Le Jolis* in Mém. Soc. Sci. Nat. Cherbourg 29: 308 (1895); Sim, Bryo. S. Afr. 272 (1926); Gangulee, Moss. E. India 5: 1158 (1976). Type species: not designated.

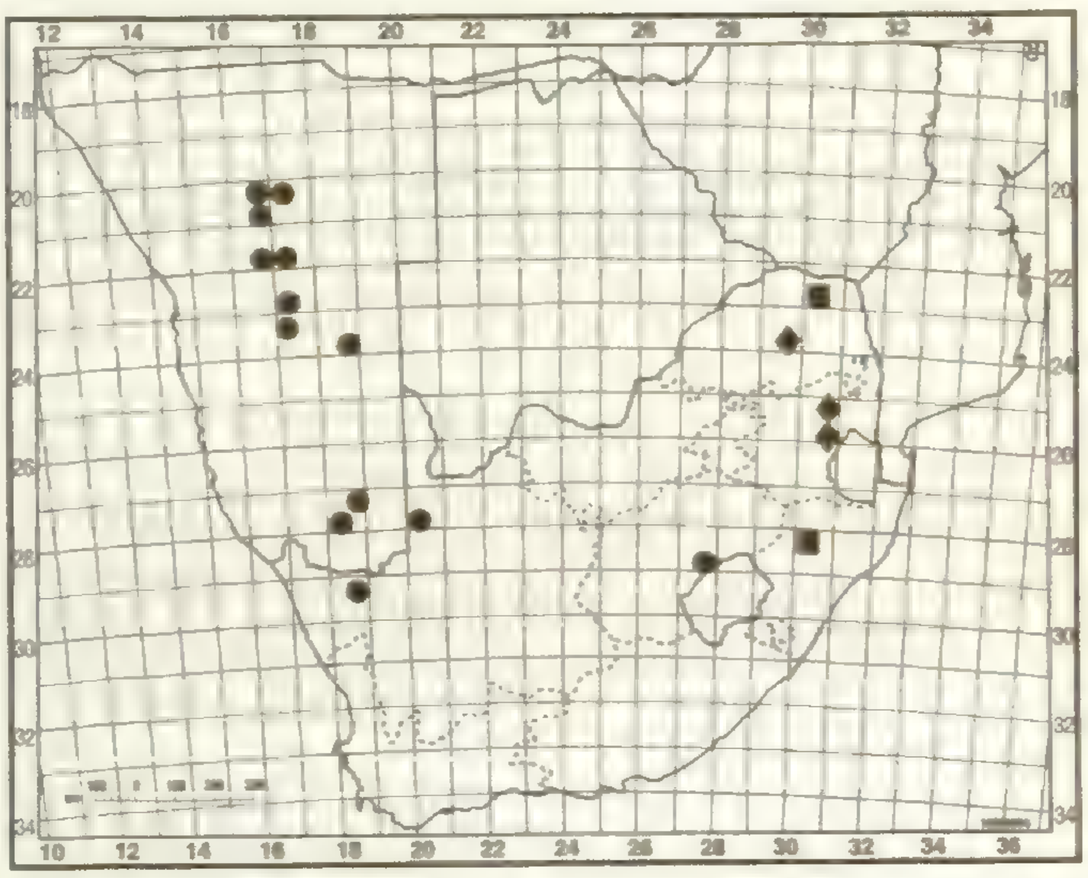
A genus of three species found in central and southern America, Africa, Madagascar, India, Sri Lanka, southern and southeastern Asia and Japan. *Rhachithecium perpusillum* is the most widespread of the three species and the only one known from the southern hemisphere.

Rhachithecium perpusillum *(Thwait. & Mitt.) Broth.* in Natürl. PflFam. 1,3: 1199 (1909); Gangulee, Moss. E. India 5: 1159 (1976). Type: Sri Lanka.

Zygodon perpusillus Thwait. & Mitt. in J. Linn. Soc., Bot. 13: 303 (1873).

Hypnodon transvaalensis C. Müll. in Hedwigia 38: 126 (1899). *Rhachithecium transvaalense* (C. Müll.) Broth. in Natürl. PflFam. 1,3: 1199 (1909); Sim, Bryo. S. Afr. 272 (1926); Crum in Bryologist 59: 32 (1956). Type: Transvaal, near Utombi between Kook and Sand Rivers, Aug. 1884, *Wilms s.n.* (PRE!).

Plants minute to small, gregarious or caespitose, yellowish green above, yellowish brown below; corticolous. *Stems* erect, to 3.5 mm tall, branching by subperichaetial innovations; rhizoids brownish, smooth; in section round, central strand of hydroids present, cortical cells in 2–4 rows, thin-walled, epidermis not differentiated. *Leaves* ± crowded, larger above, erect-incurved when dry, erect-spreading when wet, keeled; oblong to oblong-spathulate to spathulate, (0.7–)1.0–1.6(–1.8) mm long; apex subacute, mucronate or apiculate; margins plane, entire below, frequently crenulate to serrulate above, frequently flexuose. *Costa* ending well below apex, ventral superficial cells rectangular, dorsal superficial cells linear; in section crescent-shaped, ventral surface flat, laminal insertion ventral, 2 guide cells exposed ventrally, dorsal stereids in 2 or 3 rows, dorsal surface cells not differentiated. *Upper laminal cells* irregularly hexagonal, ± thin-walled, flat to bulging, 12–29 µm, smooth; basal cells yellowish, smooth, rectangular, thin-walled. *Gemmae* oblong, 3–5 cells long, 1 or 2 cells wide, 80–130 µm long, 30–50 µm wide, axillary on long stalks, yellowish or hyaline.



MAP 180.— ♦ **Rhachithecium perpusillum**
● **Ptychomitriopsis aloinoides**
■ **Ptychomitriopsis africana**

Autoicous. *Perigonia* on short branches, gemmate; inner leaves concave, broadly ovate ± apiculate, 0.2–0.5 mm long. *Perichaetia* terminal; leaves yellowish or hyaline, sheathing, covering seta, 1.2–2.4 mm long, apex acute or acuminate, cells irregularly hexagonal or rhomboidal above, rhomboidal to rectangular below, thin-walled. *Seta* thick, 1.0–1.5 mm long, yellowish to brown, twisted anticlockwise above, straight to curved above, vaginula long. *Capsule* erect to inclined, ovate-cylindrical, contracted below mouth when dry, 0.5–0.8 mm long, brownish, strongly 8-ribbed, neck short; exothecial cells irregularly rectangular to quadrate, shorter at mouth, thin-walled, cells of ribs inflated, brownish or orange; stomata present on neck, phaneropore; annulus revolvable. *Peristome* teeth 16, in 8 pairs, oblong-lanceolate, brownish or orange, recurved when dry, incurved when wet, trabeculate, smooth. *Operculum* shortly conic-apiculate, apiculus oblique, 0.2–0.3 mm long. *Calyptra* 0.4–0.6 mm long, naked, cells prorate distally, yellowish brown. *Spores* (18.5–)22.0–31.0(–35.0) µm, minutely granulate to reticulate, brownish. Fig. 129.

The species is known from southern North America, Mexico, South America, sub-Saharan Africa, Madagascar, Sri Lanka, India and China. In southern Africa *R. perpusillum* is rarely collected on bark in woodlands and forests of the northern and eastern Transvaal regions. Map 180.

Vouchers: *Kluge 1042, 1048; Magill 3607, 6502, 6504.*

The small plants, growing on bark of trees, can easily be overlooked in the field. The species can be recognized by the long-sheathing perichaetial leaves, covering the long vaginula and relatively thick seta and reaching the base

FIG. 129.—**Rhachithecium perpusillum**: **1.** habit (dry), × 10; **2.** habit (wet), × 10; **3.** stem in cross section, × 175; **4 & 5.** leaves, × 35; **6.** leaf in cross section, × 175; **7.** cells at leaf base (right side), × 175; **8.** upper laminal cells, × 350; **9.** leaf apex, × 175; **10.** axillary gemma, × 250; **11.** perichaetial leaf, × 35; **12.** part of capsule wall with stoma, × 350; **13.** part of capsule mouth with incurved peristome tooth, × 175; **14.** calyptra, × 70; **15.** spore, × 700. (1, 2, 4–11 & 14, *Kluge 1048*; 3, *Kluge 1042*; 12, *Magill 3607*; 13, *Magill 6502*.)

of the strongly 8-ribbed capsule. The oblong-spathulate leaves with irregular hexagonal, smooth upper laminal cells and the single peristome with teeth smooth, recurved when dry and incurved when wet also help to identify *R. perpusillum*.

PTYCHOMITRIACEAE

Plants small to medium-sized, loosely or densely caespitose, dark green to blackish green, glossy above, brownish and dull below; saxicolous or rarely terricolous. *Stems* erect, branching irregular; in section round, central strand small, inner cortical cells in 4 or 5 rows, thin-walled, yellowish, outer cortical cells in 2–4 rows, somewhat thickened, reddish. *Leaves* erect-spreading with plane to erect or rarely involute margins wet, incurled with involute margins dry; margins and/or lamina generally bistratose, occasionally unistratose or multistratose. *Costa* smooth dorsally, smooth or mammillose ventrally; in section with guide cells and dorsal and ventral stereid bands. *Laminal cells* rounded-quadrate to short-rectangular or transversely rectangular especially near margins, smooth, ± thickened; alar cells not differentiated.

Autoicous. *Perichaetia* terminal becoming lateral through innovation, occasionally polysetaceous; perichaetial leaves undifferentiated or somewhat narrower. *Seta* erect, short or long. *Capsule* erect, symmetrical, ovoid to short-cylindrical; exothecial cells irregularly rectangular, thin-walled; stomata present at base of urn; annulus present. *Peristome* single, teeth 16, narrow-triangular, cleft or perforated, ± fragile, ornately papillose. *Operculum* long-beaked. *Calyptra* mitrate, deeply lobed, ± plicate, naked. *Spores* small.

A small family with four genera, two of which occur in southern Africa. *Ptychomitrium* is a large, widespread genus found on rocks, generally in open, upland sites. *Ptychomitriopsis* is endemic to southern Africa and is found on rocks in dry grasslands.

In view of the evidence presented by Edwards (1979) on peristome development, this family and most of its genera are incorrectly placed in the Diplolepidae and belong to the Haplolepidae near Grimmiaceae.

Leaf lamina unistratose, or if bistratose then leaf margins broadly involute when wet; laminal cells mostly larger than 10 µm . . . . . 1. **Ptychomitriopsis**
Leaf lamina bistratose, or only margin bistratose, leaf margin plane to erect when wet; laminal cells mostly smaller than 10 µm . . . . . 2. **Ptychomitrium**

1. PTYCHOMITRIOPSIS

Ptychomitriopsis *Dix.* in J. Bot. 69: 284 (1931). Type species: *P. africana* Dix.

Plants small; saxicolous. *Stems* erect. *Leaves* oblong to narrowly elliptical; obtuse to rounded; margins plane to broadly involute, entire. *Costa* subpercurrent or ending below apex, ventral superficial cells similar to laminal cells, smooth, dorsal superficial cells long-rectangular, thickened, smooth. *Laminal cells* small, weakly thickened.

Autoicous. *Seta* short, 2–3 mm long. *Capsule* cylindrical to ellipsoidal. *Peristome* teeth 16, cleft and perforated. *Spores* small, essentially smooth to weakly papillose.

Ptychomitriopsis contains only two species, both endemic to southern Africa. The genus has been rarely collected, perhaps because of its small stature and occurrence in dry grassland habitats.

Macroscopically the genus is easily confused with small plants of *Ptychomitrium*. The genus is separated from *Ptychomitrium* by smaller overall size, larger laminal cells, shorter basal cells, and differences in leaf shape and anatomy.

Leaves bistratose, upper margins broadly involute . . . . . .1. *P. aloinoides*
Leaves unistratose, upper margins plane . . . . . 2. *P. africana*

1. **Ptychomitriopsis aloinoides** *Magill*, sp. nov., *bene distincta a speciebus aliis* Ptychomitriopsidis *Dix., foliis bistratosis et marginibus late involutis*. Type: (Orange) Free State, north slope of Wonderkop between Rosendal and Marquard, 2827DA, on sandstone boulder, 1800 m. *Van Rooy 439* (MO, holo.!; BM, NY, PRE).

Plants small, loosely caespitose, green to yellow-green; saxicolous. *Stems* 2–4 mm tall, rarely branched; in section round, central strand small, inner cortical cells in 2 or 3 rows, large, thin-walled, outer cortical cells in 1 or 2 rows, smaller, thin-walled, brownish. *Leaves* ± crowded, erect-spreading wet, incurved and appressed dry; bistratose above base; oblong to lingulate, 1.0–1.5 mm long; obtuse to rounded; base scarcely differentiated; margins entire, plane to erect below, broadly involute above. *Costa* ending below apex to subpercurrent; in section elliptical, guide cells 4, distinct, ventral stereid band small, 2 cells thick, ventral surface cells similar to ventral laminal cells, forming a continuous ventral layer, dorsal stereid band strong, (2)3 or 4 cells thick, dorsal surface cells small, incrassate but more strongly thickened on outer wall. *Upper laminal cells* rounded-quadrate to transversely rectangular (7–)11–14 µm, smooth; basal cells somewhat larger, short-rectangular, thin-walled, hyaline.

Autoicous. *Perichaetia* terminal, leaves not differentiated. *Seta* 2.0–3.5 mm long, yellowish to brownish. *Capsule* ellipsoidal, 1.0–1.2 mm long, brownish; annulus present, red. *Peristome* teeth 0.14 mm high, cleft and perforated, reddish yellow. *Operculum* rostrate, 0.7 mm long. *Calyptra* mitrate, 1.0–1.5 mm long. *Spores* rounded to ± angular, 9–13 µm, essentially smooth, light green to yellowish. Fig. 130: 13–18.

Endemic to southern Africa, *P. aloinoides* is found on sandstone rocks or rock crevices in grassland or shrubland of the Free State, northern and northwestern Cape regions and Namibia. Map 180.

Vouchers: *Barnard CH-5762; Magill 6458; Volk 5349.*

This species differs from *P. africana* in its broadly involute upper leaf margins, bistratose lamina and slightly larger spores. The species is separated from *Ptychomitrium* by its small stature, larger leaf cells and leaf shape.

2. **Ptychomitriopsis africana** *Dix.* in J. Bot. 69: 284 (1931). Type: Transvaal, Soutpansberg, Lake Fundudzi, *Wager 112* (BM, holo.!; PRE).

Ptychomitrium africanum (Dix.) Churchill in Funk & Brooks, Advances in cladistics 143 (1981).

Ptychomitrium godfreyi Robinson in Bryologist 62: 225 (1960). Type: Natal, 25 miles NE of Ladysmith. 20 Feb. 1953, *Godfrey* (Duke, holo.!; NY, PRE, US).

Plants small, loosely to densely caespitose, green to yellow-green; saxicolous. *Stems* 3–5 mm tall, sparsely branched; in section round, central strand large, inner cortical cells in 2 or 3 rows, large, thin-walled, outer cortical cells in 1(2) row(s), ± smaller, thin-walled, brownish. *Leaves* erect-spreading wet, incurved and ± crisped dry; unistratose; narrowly elliptical to oblong, 2.0–2.5 mm long; obtuse to rounded and short-apiculate; tapering to base; margins plane, entire. *Costa* subpercurrent; in section elliptical, guide cells 4, small, ventral stereid band small, 2 cells thick, ventral surface cells large, similar to laminal cells, thin-walled, dorsal stereid band 2 or 3 cells thick, dorsal surface cells small, thickened or occasionally substereids. *Laminal cells* subquadrate to ± transversely rectangular, (8–)11–14 µm, firm-walled; basal cells hyaline, short-rectangular, 2:1 to 3:1, thin-walled.

Perichaetia terminal, leaves undifferentiated. *Seta* 2–3 mm long, yellowish. *Capsule* cylindri-

cal, 1.0–1.3 mm long, brownish with red mouth. *Peristome* teeth lanceolate, cleft, papillose, reddish. *Operculum* rostrate, 0.7 mm long. *Calyptra* mitrate, 0.8 mm long. *Spores* rounded, 7–8 µm, yellowish, weakly papillose. Fig. 130: 1–12.

Ptychomitriopsis africana is endemic to southern Africa. It is found on rock in grassland in KwaZulu-Natal and the northern Transvaal region. Map 180.

Vouchers: types only.

This species is identified by its small size, narrowly elliptical leaves with rounded-obtuse apices, and unistratose leaf lamina. As indicated by Dixon (1931), the leaf cells of this plant are 'large, very distinct and pellucid', clearly separating it from other southern African members of this family.

2. PTYCHOMITRIUM

Ptychomitrium *Fuernr.* in Flora 2: 19 (1829), nom. cons.; Broth. in Natürl. PflFam., edn 2, 11: 8 (1925); Sim, Bryo. S. Afr. 213 (1926); Catcheside, Moss. S. Austr. 207 (1980); Crum & Anderson, Moss. E.N. Amer. 2: 666 (1981). Type species: *P. polyphyllum* (Sw.) B.S.G.

Brachysteleum Reichenb., Consp. regn. veg. 1: 34 (1828), nom. rejec.; C. Müll., Syn. musc. frond 1: 766 (1849). Type species: *B. crispatum* (Hedw.) Hornsch.

Notarisia Hampe in Linnaea 11: 379 (1837). Type species: *N. virginica* Hampe.

Plants medium-sized; saxicolous or terricolous. *Leaves* tightly incurled dry, widespreading wet; linear-lanceolate to ovate-lanceolate or ligulate above ovate to oblong base; margins plane to erect, bistratose, or complete lamina bistratose, occasionally multistratose juxtacostally. *Costa* percurrent to subpercurrent; ventral superficial cells smooth to mammillose, similar to laminal cells; dorsal superficial cells smooth, rectangular, thickened. *Laminal cells* firm-walled to thickened.

Autoicous. *Seta* short or long. *Capsule* ovoid to short-cylindrical. *Peristome* teeth ± fragile, mostly cleft and perforated. *Spores* granulate to weakly papillose.

Ptychomitrium contains 74 species found on rock or soil in rock crevices in temperate regions of both hemispheres. The plants are generally fully exposed and have a distinctive dark green but glossy appearance.

In southern Africa, the genus is most frequently found around rock outcrops in grassland or shrubland of the eastern and southern *Flora* area.

1 Leaf margins bistratose, lamina unistratose or with bistratose patches . . . . . 1. *P. subcrispatum*
1 Leaf lamina bistratose, occasionally multistratose juxtacostally:
 2 Laminal cells strongly mammillose:
  3 Ventral laminal cells mammillose; dorsal laminal cells ± flat or occasionally papillose marginally, mostly smaller than ventral cells; eastern Transvaal region, Swaziland, Zululand . . . . . 2. *P. exaratifolium*

FIG. 130.—**Ptychomitriopsis africana** (1–12): **1.** habit (dry), × 5; **2.** habit (wet), × 10; **3.** stem in cross section, × 175; **4.** leaf, × 35; **5.** leaf in cross section, × 175; **6.** basal leaf cells, × 350; **7.** upper laminal cells, × 700; **8.** leaf apex, × 175; **9.** part of capsule mouth with peristome teeth, × 175; **10.** operculum, × 70; **11.** calyptra, × 35; **12.** Spores, × 700. **P. aloinoides** (13–18): **13.** habit (dry), × 5; **14.** habit (wet), × 10; **15.** leaf, × 35; **16.** leaf in cross section, × 175; **17.** part of peristome, × 350; **18.** spores, × 700. **Ptychomitrium subcrispatum** (19–23): **19.** habit (dry), × 1; **20.** habit (wet), × 5; **21.** leaf, × 35; **22.** leaf in cross section, × 175; **23.** leaf apex, × 175. (1–12, *Wager 112*; 13 & 14, *Giess 15385*; 15–17, *Russell 3932*; 18, *Volk 5349*; 19 & 22, *Schelpe 7583*; 20, *Magill 5675*; 21, *Van Rooy 455*; 23, *Cholnoky 4*.)

3 Ventral and dorsal cells mammillose, similar in size and shape; Drakensberg of Lesotho and western KwaZulu-Natal . . . . . 3. *P. diexaratum*
2 Laminal cells smooth or bulging:
4 Leaf margins revolute in base . . . . . 4. *P. depressum*
4 Leaf margins plane to ± reflexed in base:
5 Leaves abruptly ligulate above distinct obovate base . . . . . 5. *P. eurybasis*
5 Leaves linear-lanceolate to ovate- or oblong-lanceolate, base not pronounced:
6 Leaf apex distinctly cucullate; leaves 2–3 mm long . . . . . 6. *P. cucullatifolium*
6 Leaf apex acute (or rarely subcucullate); leaves 3–5 mm long:
7 Laminal cells 11–15 µm long; basal leaf cells short-rectangular, very thin-walled; costa broad, in transverse section elliptical, ventral surface cells large, thin-walled, distinct . . . . . 7. *P. crassinervium*
7 Laminal cells less than 10 µm long; basal leaf cells rectangular to long-rectangular, ± thickened; costa narrow, in transverse section rounded, ventral surface cells differentiated but generally not as distinct . . . . . 8. *P. crispatum*

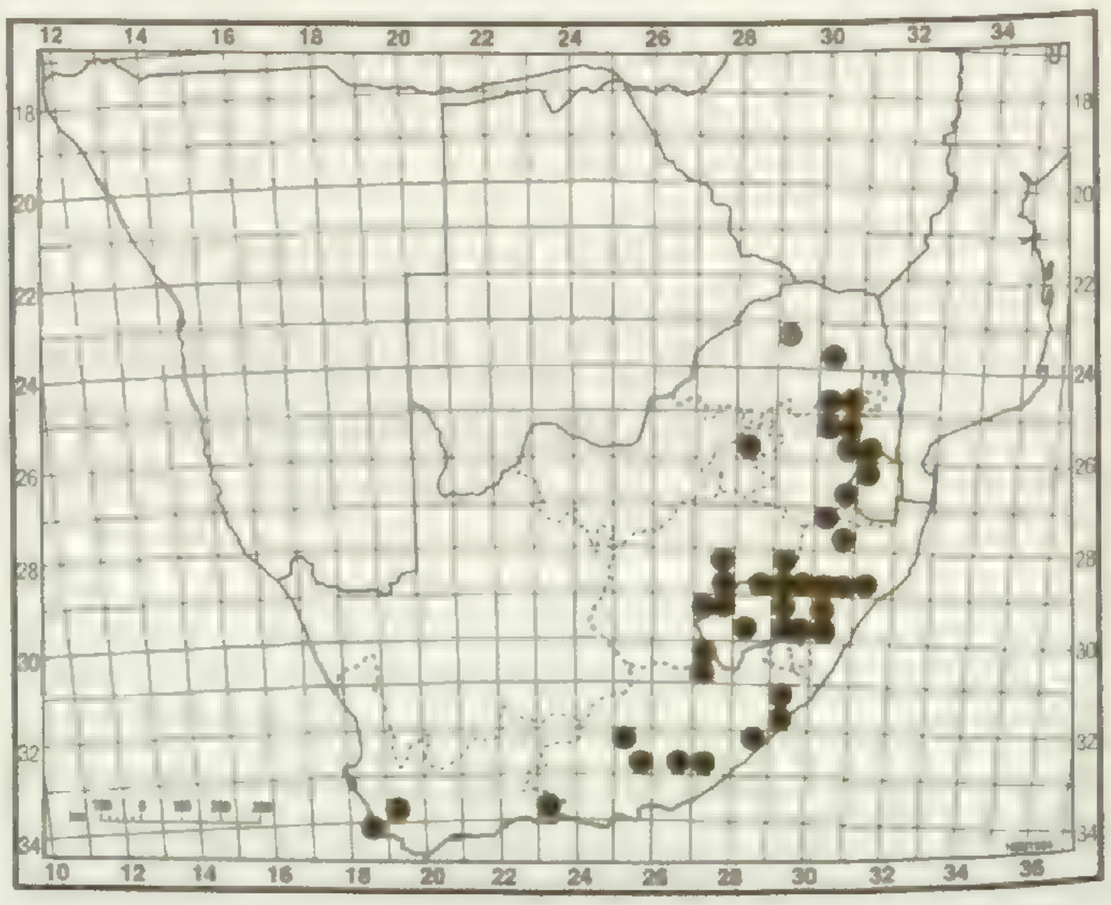
1. **Ptychomitrium subcrispatum** *Thér. & P. Varde* in Revue Gén. Bot. 30: 65 (1918); Broth. in Natürl. PflFam., edn 2, 11: 9 (1925); Sim, Bryo. S. Afr. 216 (1926); De Sloover in Bull. Jard. Bot. Belg. 46: 437 (1976). Type: Natal, Van Reenen, 5000 ft, *Wager no. 2* (PC, holo.!).

Glyphomitrium marginatum Wager & Dix. in Trans. Roy. Soc. South Africa 8: 196 (1920). *Ptychomitrium marginatum* (Wager & Dix.) Dix. in S. African J. Sci. 18: 315 (1922); Broth. in Natürl. PflFam., edn 2, 11: 9 (1925); Sim, Bryo. S. Afr. 216 (1926). Syntypes: Transvaal, Kaapsche Hoop, *Wager 298* (BM!, PRE!); Cape, Hogsback, Tjumie, *D.B. & M. Henderson 190* (BM!); *D. Henderson 352b* (BM!).

Plants medium-sized, loosely caespitose, dark green; saxicolous or terricolous. *Stems* 10–25(–40) mm tall, irregularly branched. *Leaves* incurved or appressed, with crisped apex dry, erect-spreading wet; linear-lanceolate to ovate- or oblong-lanceolate, (2.5–)3.5–4.5(–5.0) mm long; acute to subcucullate; margins bistratose, upper lamina unistratose, frequently with bistratose patches. *Costa* percurrent, dorsal and ventral superficial cells smooth; in section bulging dorsally, guide cells 6, distinct, ventral stereid band 3 or 4 cells thick, ventral surface cells large and thin-walled, becoming smaller and thickened distally, dorsal stereid band 4 or 5 cells thick, dorsal surface cells small and thickened, not differentiated distally. *Upper laminal cells* rounded-quadrate, becoming transversely rectangular towards margins, 8.0–11.5 µm, ± heterogeneous; basal cells short-rectangular to rectangular, thin-walled, yellowish.

Seta variable, 1.0–3.5(–10.0) mm long, yellow to brown. *Capsule* short-cylindrical, 1.2–1.5 mm, brownish. *Peristome* teeth cleft and perforated, ornately papillose. *Operculum* rostrate. *Calyptra* mitrate, 1 mm long, long-beaked. *Spores* round, 14–16 µm, brownish, granulate. Fig. 130: 19–23.

This species is known from southern Africa, Zimbabwe, Réunion and Macaronesia. In the *Flora* area it is found on soil and rock in grassland and shrubland communities of the south-western, southern and eastern Cape regions, Free State, Lesotho, KwaZulu-Natal, Zululand, Swaziland and the central, eastern and northern Transvaal regions. Map 181.



MAP 181.—**Ptychomitrium subcrispatum**

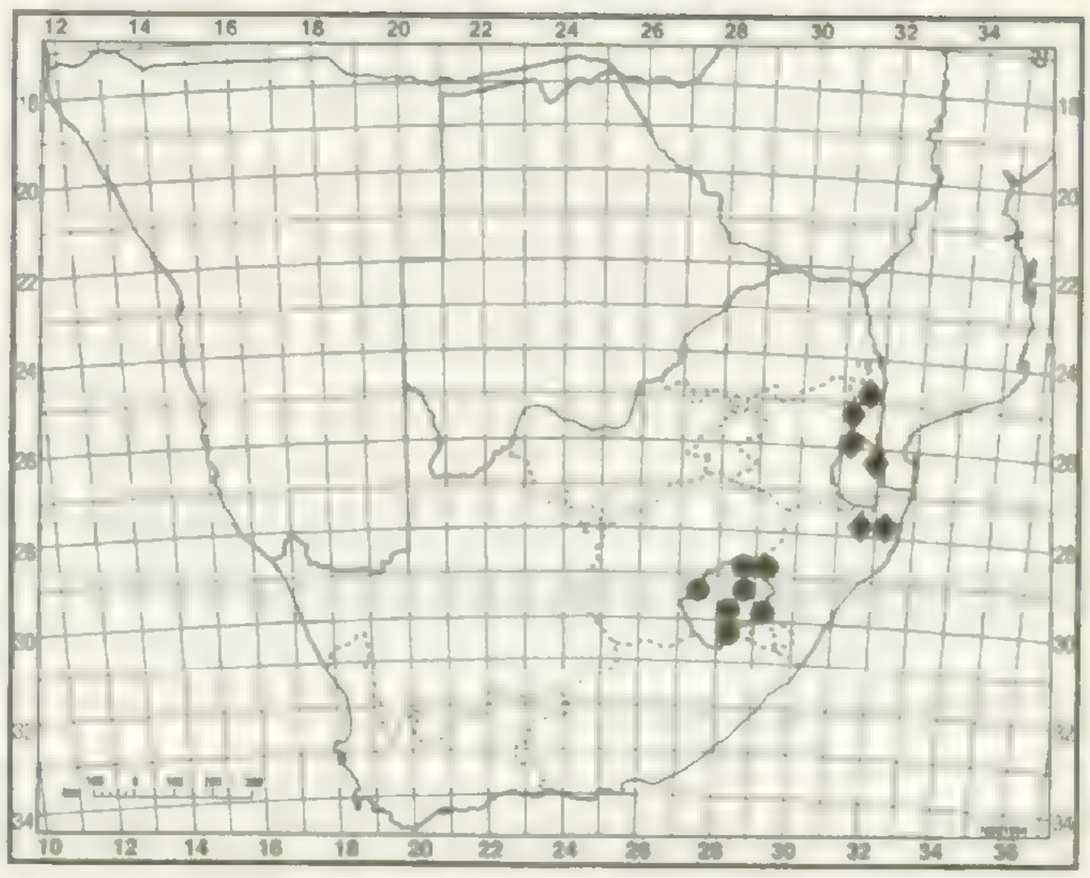
Vouchers: *Hilliard & Burtt 14085; Magill 4143, 6318; Van Rooy 455; Schelpe 7583.*

The species is most easily identified by its bistratose leaf margins and mostly unistratose lamina. Occasionally the lamina has bistratose patches but these are generally small; see note under *P. crispatum* (p. 475).

The name *P. marginatum* Dix. was used to describe a variant of this species with long setae and slight differences in basal leaf cell development. Some specimens have been examined with very long setae (up to 10 mm), and capsules at the upper end of the size range of *P. subcrispatum* (1.5 mm); however, these specimens agree in all other respects with this species. Seta length has not proven to be a reliable character for the separation of species and indeed the specimens examined show a great deal of variation in this character.

2. **Ptychomitrium exaratifolium** *Robinson* in Bryologist 62: 227 (1963). Type: Transvaal, Kruger National Park, vicinity of Pretorius Kop, 15 Jan. 1953, *R.K. Godfrey s.n.* (DUKE, holo.; NY!, US).

Plants small to medium-sized, caespitose, dark green to yellow-green; saxicolous. *Stems* 5–10 mm tall, infrequently branched. *Leaves* circinate-crisped dry, erect-spreading wet; lanceolate from a broad obovate base, 3–4 mm long; apex weakly cucullate; sheathing at base; lamina and margins bistratose above base. *Costa* subpercurrent to percurrent, ventral superficial cells mammillose, dorsal superficial cells smooth; in section elliptical, guide cells 6, incrassate, ventral stereid band 1 or 2 cells thick, cells sometimes substereid, ventral surface cells mammillose, dorsal stereid band 2–4 cells thick, dorsal surface cells incrassate. *Upper laminal cells* subquadrate, 5–10 µm, thickened, ventral cells mammillose, dorsal cells almost always shorter than ventral cells, smooth or infrequently papillose or weakly mammillose near margin; basal cells rectangular below, becoming quadrate at shoulders, thin-walled.



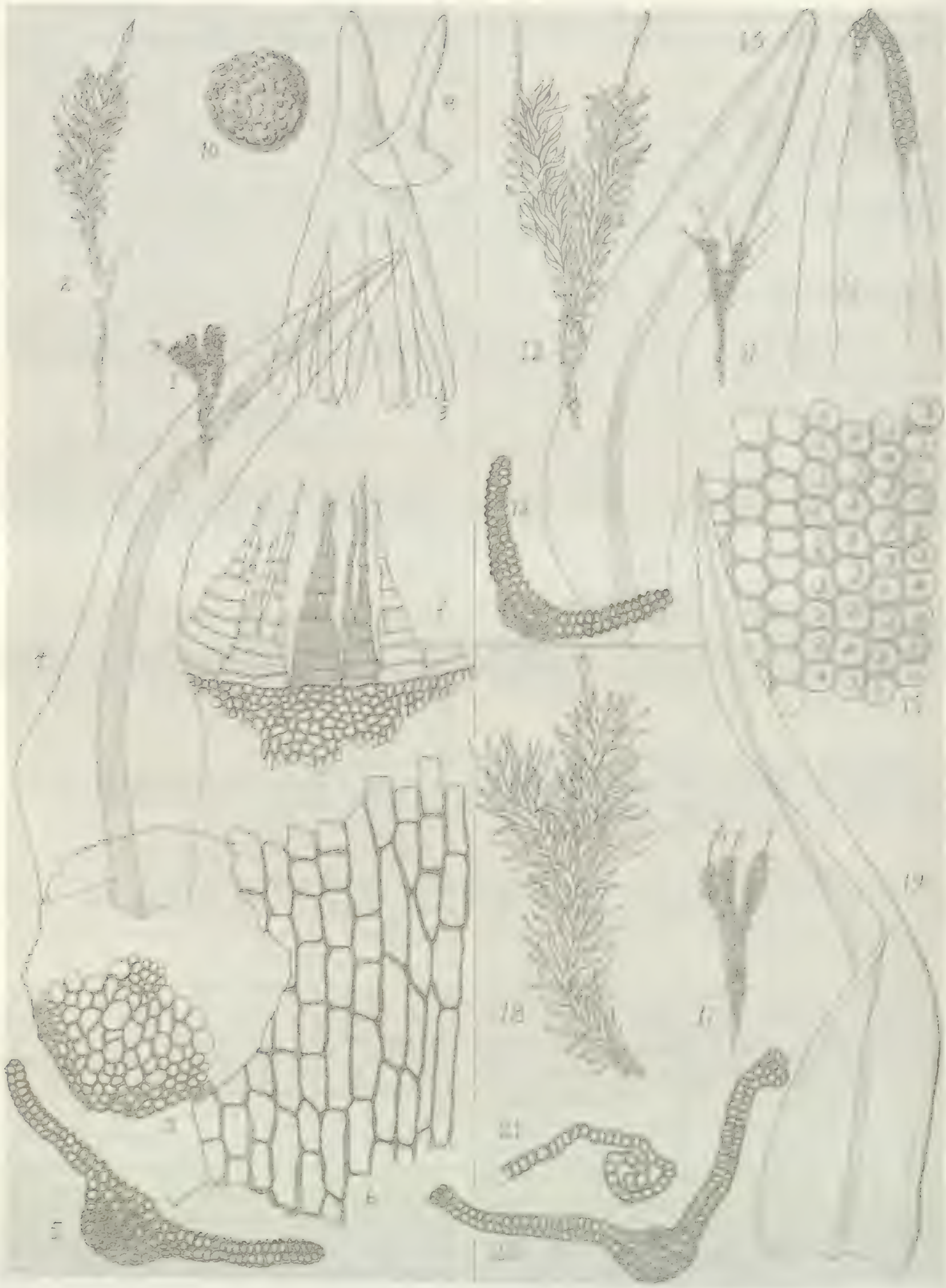
MAP 182.— ♦ **Ptychomitrium exaratifolium**
● **Ptychomitrium diexaratum**

Seta 2.0–3.5 mm long, reddish yellow. *Capsule* ovoid, 1.0(–1.5) mm long. *Peristome* teeth lanceolate, cleft above, papillose, reddish. *Operculum* rostrate, 0.7 mm long. *Calyptra* mitrate, 1.8 mm long. *Spores* rounded to ellipsoid, 20–30 µm, yellow-brown, granulate. Fig. 131: 1–10.

Endemic to southern Africa, *P. exaratifolium* is found on rock, especially dolerite, in grassland of the eastern Transvaal region, Swaziland and Zululand. Map 182.

Vouchers: *Magill 3578, 5480; Van Vuuren 1697, 1796.*

This species is identified by its strongly mammillose ventral leaf cells, generally shorter and smooth dorsal leaf cells and obovate leaf base. Occasionally the dorsal leaf cells are almost as high as the ventral cells and sometimes papillose to weakly mammillose towards the leaf margins. These specimens could be confused with *P. diexaratum*, although the dorsal cells are never as regularly mammillose (see p. 469). *P. exaratifolium* also shows some resemblance to *P. eurybasis*, especially in leaf shape; however, its leaf cells are flat and not mammillose. From illustrations the Mexican species *P. standleyi* Crum looks very close to *P. exaratifolium*. A few other species are apparently disjunct between Mexico and South Africa, e.g. *Syntrichia chisosa* (Magill, Delgad. & L.R. Stark) R.H. Zander.



3. **Ptychomitrium diexaratum** *Magill* in *Magill & Schelpe* in Mem. bot. Surv. S. Afr. 43: 3 (1979). Type: Lesotho, Sehlabathebe National Park, in crevices of wet sandstone cliffs, grassland, 2400 m, *Magill 4308* (PRE, holo.!; H, L, MO, NY).

Plants small to medium-sized, caespitose, dark green to yellow-green, brownish below; saxicolous. *Stems* (5–)10–15(–20) mm tall, occasionally branching above. *Leaves* crowded, ± contorted to circinate-incurved dry, erect-spreading to widespreading wet; lanceolate to occasionally acuminate above oblong or elliptical base, (2.0–)3.5–4.5 mm long; bistratose above base, occasionally tristratose juxtacostally; apex acute to subcucullate; not narrowing to insertion; margins plane or occasionally reflexed in base. *Costa* percurrent to subpercurrent, ventral superficial cells mammillose, dorsal superficial cells smooth; in section bulging dorsally, guide cells 6–8, ventral stereid band 1(2) cell(s) thick, ventral surface cells similar to ventral laminal cells, mammillose, dorsal stereid band 2 or 3 cells thick, dorsal surface cells substereids with conspicuously thickened outer walls. *Upper laminal cells* quadrate to rounded-quadrate, 6–10 µm, thickened, mammillose on dorsal and ventral leaf surfaces; basal cells rectangular to long-rectangular, yellowish to hyaline, thin-walled.

Seta 2–5 mm long, yellow-brown. *Capsule* short, elliptical to ovoid, (1.0–)1.5–2.0 mm long, yellowish brown. *Peristome* teeth fragile, narrowly triangular, cleft and perforated, ornately papillose, orange-yellow. *Operculum* rostrate, 1 mm long. *Calyptra* mitrate, 2.0–2.5 mm long. *Spores* rounded to angular, 12–18 µm, green to brown, verrucate. Fig. 131: 11–16.

Endemic to southern Africa, *P. diexaratum* is found on rock in high grassland communities of Lesotho and western KwaZulu-Natal. Map 182.

Vouchers: *Hilliard & Burtt 10409; Jacot Guillarmod 6098, 6102; Magill 4199, 4270, 4695.*

This species is very closely related to *P. exaratifolium* and is unlikely to be confused with any other species. *Ptychomitrium diexaratum* is identified by the similar shape and size of its dorsal and ventral leaf cells. Both leaf surfaces are strongly and evenly mammillose. The weakly differentiated oblong to elliptical leaf base and smaller spores are also useful characters. In addition, the leaves of this species are occasionally tristratose juxtacostally. A few leaves with somewhat smaller dorsal leaf cells that are weakly mammillose have been examined, but conform in other respects to *P. diexaratum*.

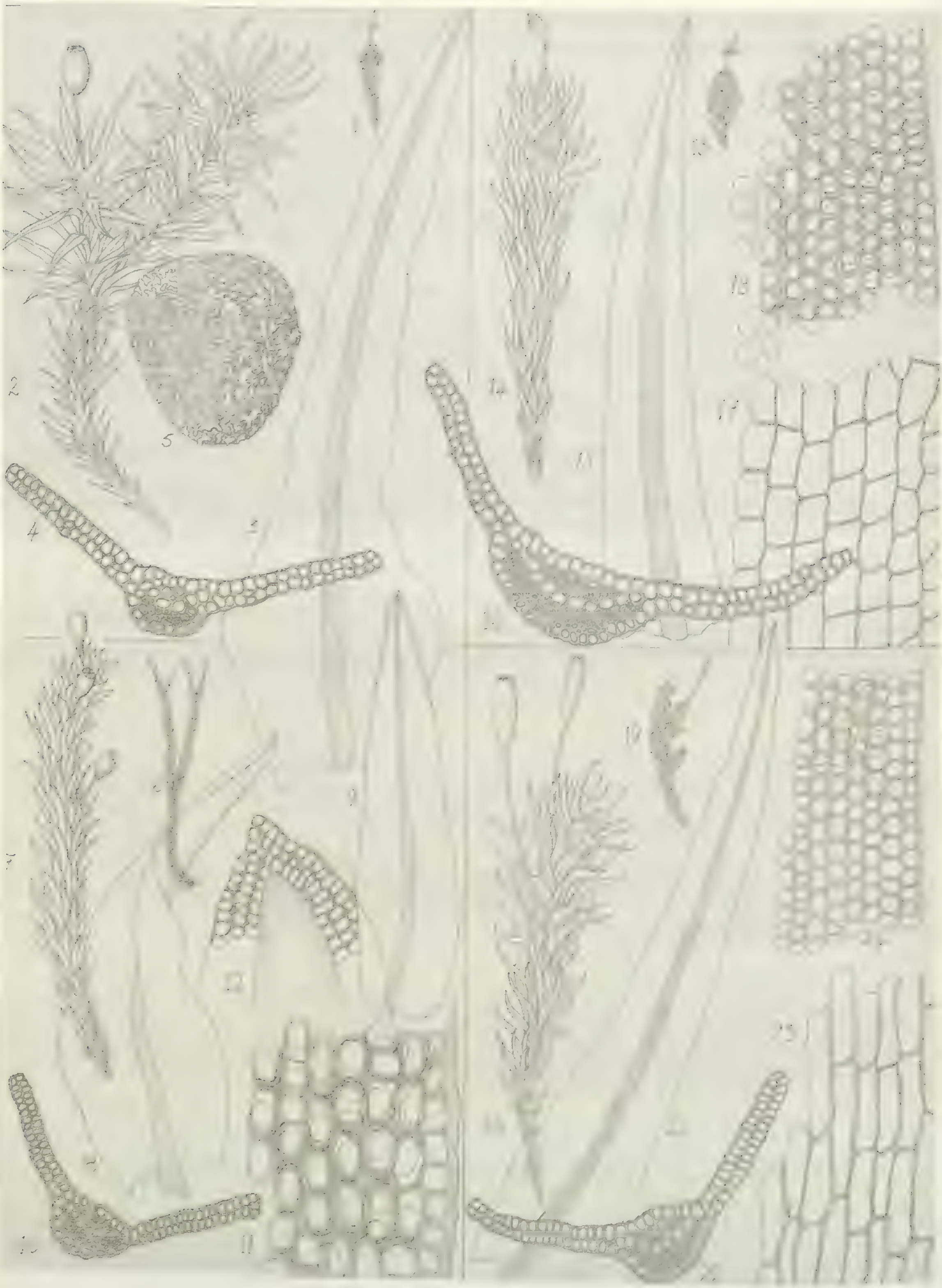
The two species are also separated spatially, with *P. diexaratum* confined to upper elevation grassland sites in the southern Drakensberg and *P. exaratifolium* found in the lowveld of the eastern Transvaal region, Swaziland and Zululand.

4. **Ptychomitrium depressum** *(C. Müll.) Par.*, Ind. bryol. suppl. 1: 289 (1900); Broth. in Natürl. PflFam., edn 2, 11: 9 (1925); Sim, Bryo. S. Afr. 214 (1926). Type: Natal, Jammerlappen, *J. Dittrich s.n.*, 1898.

Brachysteleum depressum C. Müll. in Hedwigia 38: 153 (1899). *Glyphomitrium depressum* (C. Müll.) Broth. in Natürl. PflFam. 1,3: 441 (1902); Dix. in Trans. Roy. Soc. South Africa 8: 196 (1920).

Plants medium-sized, caespitose, green; saxicolous. *Stems* (5–)10–25 mm high, little branched. *Leaves* crowded, incurved and ± crisped dry, erect- to widespreading wet; narrowly acuminate above oblong base, 4–5 mm

FIG. 131.—**Ptychomitrium exaratifolium** (1–10): **1.** habit (dry), × 1; **2.** habit (wet), × 3; **3.** stem in cross section, × 175; **4.** leaf, × 35; **5.** leaf in cross section, × 175; **6.** basal leaf cells, × 350; **7.** part of capsule mouth with peristome teeth, × 175; **8.** operculum, × 35; **9.** calyptra, × 35; **10.** spore, × 700. **P. diexaratum** (11–16): **11.** habit (dry), × 1; **12.** habit (wet), × 3; **13.** leaf, × 35; **14.** leaf in cross section, × 175; **15.** upper laminal cells, × 700; **16.** leaf apex, × 175. **P. depressum** (17–21): **17.** habit (dry), × 1; **18.** habit (wet), × 3; **19.** leaf, × 35; **20.** leaf in cross section, × 175; **21.** basal leaf margin in cross section, × 175. (1, 2, 7–10 & 12, *Van Vuuren 1796*; 3–5, *Magill 5480*; 6, *Magill 4780*; 11, *Magill 4695*; 13 & 15, *Jacot Guillarmod 6102*; 14, *Magill 4308*; 16, *Magill 4201*; 17 & 18, *Pegler 1236*; 19, *Schelpe 7568*; 20, *Van Zanten 7609663*; 21. *Jacot Guillarmod PRE-CH12844*.)



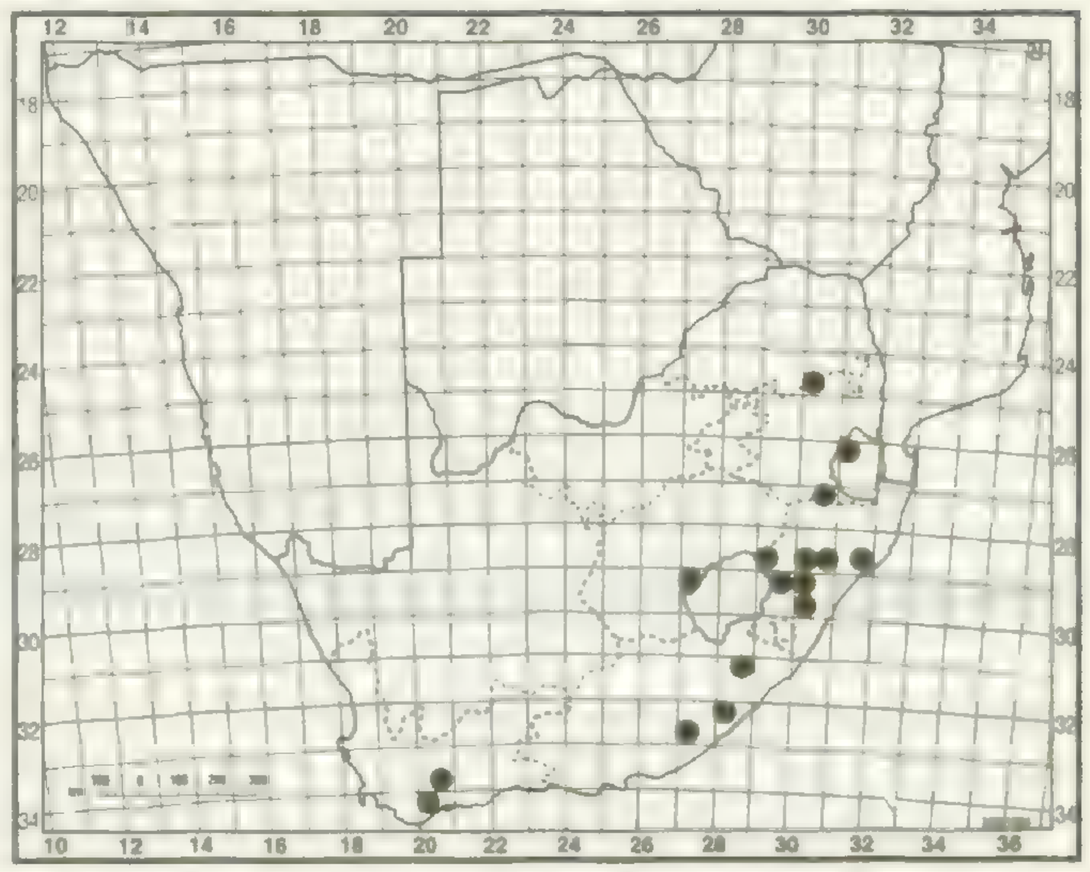
long; acute; bistratose and frequently tristratose at margins; base weakly sheathing; margins plane above, spirally revolute in base. *Costa* percurrent, smooth dorsally and ventrally; in section bulging dorsally, guide cells 6, distinct, ventral stereid band 2 or 3 cells thick, ventral surface cells smaller than laminal cells, thickened, dorsal stereid band 3 cells thick, dorsal surface cells small, incrassate. *Upper laminal cells* small, variable in size and shape, rounded-quadrate to hexagonal or transversely short-rectangular, 4–6 µm, incrassate; basal cells long-rectangular to linear juxtacostally, abruptly short-rectangular to quadrate at margins, yellowish, thickened.

Seta 2–3 mm long, yellow-brown. *Capsule* elliptical, 1.5 mm long, yellow-brown, mouth reddish. *Peristome* teeth narrowly triangular, variably perforated. *Operculum* long-rostrate, 1 mm long. *Calyptra* mitrate, lobed below, 2 mm long. *Spores* rounded, (12–)14(–16) µm, yellowish, granulate. Fig. 131: 17–21.

Endemic to southern Africa, *P. depressum* is found in grassland, and open woodland and forest communities of the eastern Transvaal area, Swaziland, Zululand, KwaZulu-Natal, the Free State, and eastern and southwestern Cape regions. Map 183.

Vouchers: *Jacot Guillarmod 6143; Kemp 897; Magill 3522; Schelpe 7568; Taylor 446; Van Zanten 7609663.*

Closely related to *P. crispatum*, but the spirally revolute basal leaf margins of *P. depressum* easily separate the two species. As indicated by Dixon (1920), the revolute basal leaf margins of *P. depressum* are unique in the family.

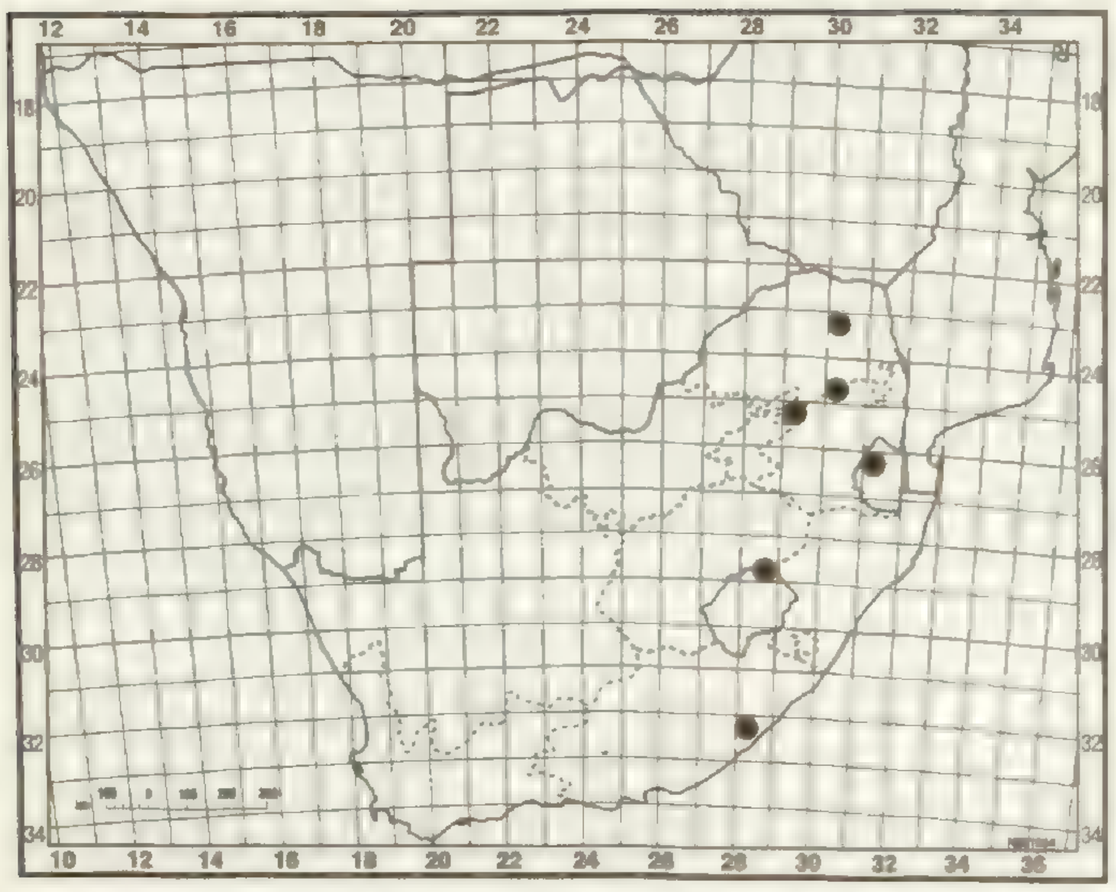


MAP 183.—**Ptychomitrium depressum**

5. **Ptychomitrium eurybasis** *Dix.* in S. African J. Sci. 18: 316 (1922); Broth. in Natürl. PflFam., edn 2, 11: 9 (1925); Sim, Bryo. S. Afr. 215 (1926). Syntypes: Zimbabwe, Macheke, *Eyles 1994*; Matopos, *Sim 885l*; Zimbabwe, *Sim 8808* (BM!, PRE!).

Plants small to medium-sized, caespitose, dark green to blackish green; saxicolous. *Stems* 8–12 mm tall, irregularly and infrequently branched. *Leaves* crowded, incurved and ± contorted above dry, erect-spreading wet; abruptly ligulate above obovate base, 3–4 mm long; acute; bistratose; base appressed, ± sheathing; margins frequently multistratose. *Costa* percurrent to subpercurrent, smooth dorsally and ventrally; in section elliptical, guide cells 6, occasionally with auxiliary cells, ventral stereid band ± irregular, 1(2) cell(s) thick, cells frequently not thickened, ventral surface cells smaller than laminal cells, thin-walled, dorsal stereid band 2 cells thick, dorsal surface cells

FIG. 132.—**Ptychomitrium eurybasis** (1–5): **1.** habit (dry), × 1; **2.** habit (wet), × 5; **3.** leaf, × 35; **4.** leaf in cross section, × 175; **5.** spore, × 700. **P. cucullatifolium** (6–12): **6.** habit (dry), × 1; **7.** habit (wet), × 5; **8 & 9.** leaves, × 35; **10.** leaf in cross section, × 175; **11.** upper laminal cells, × 700; **12.** leaf apex (cells partly shown), × 350. **P. crassinervium** (13–18): **13.** habit (dry), × 1; **14.** habit (wet), × 5; **15.** leaf, × 32; **16.** leaf in cross section, × 175; **17.** basal leaf cells, × 320; **18.** upper laminal cells, × 350. **P. crispatum** (19–24): **19.** habit (dry), × 1; **20.** habit (wet), × 5; **21.** leaf, × 35; **22.** leaf in cross section, × 175; **23.** basal leaf cells, × 350; **24.** upper laminal cells, × 350. (1–5, *Junod 1*; 6, *Van Rooy 1476*; 7, *Hilliard & Burtt 13144*; 8, *Magill 5897*; 9, *Deall & Killick 101*; 10, *Schelpe 2119*; 11, *Hilliard & Burtt 10463*; 12, *Oliver 3231*; 13, *Smook 3585*; 14, *Cholnoky 617*; 15 & 17, *Magill 3970*; 16, *Van der Westhuizen & Deetlefs 27*; 18, *Esterhuysen 15655*; 19, *Anderson PRE-CH13296*; 20, *Magill 5991*; 21–23, *Van Zanten 7609895*; 24, *Garside 6579*.)



MAP 184.—**Ptychomitrium eurybasis**

not clearly defined, small, outer walls more strongly thickened. *Upper laminal cells* rounded-quadrate, occasionally short-rectangular or transversely rectangular, 7–12 µm, larger juxtacostally; basal cells rectangular, thin-walled, yellowish, becoming shorter above.

Seta 2–3(–5) mm long, yellow-brown. *Capsule* narrowly elliptical, 1.0–1.8 mm long, yellow- to red-brown, mouth red. *Peristome* teeth fragile, perforated. *Operculum* rostrate, 1 mm long. *Calyptra* mitrate, 2.0–2.4 mm long. *Spores* rounded, variable in size, 38–40 or 50–52 µm, green, granulate. Fig. 132: 1–5.

This species is known from Malawi, Zimbabwe and South Africa. In the *Flora* area a few specimens have been collected in grassland communities of the northern, eastern, and central Transvaal regions, Swaziland, Free State and the eastern Cape. Map 184.

Vouchers: *Magill 3138, 6604; Retief 661; Pegler 2151.*

Ptychomitrium eurybasis is identified by its distinctly obovate leaf base, long, ligulate blade and flat, smooth, non-mammillate leaf cells. The spores of this species are much larger than those of the other southern African species. The two fertile specimens examined from the *Flora* area exhibited considerable differences in spore size, one ranging from 38–40 µm, the other from 50–52 µm. Otherwise the two specimens were quite similar.

6. **Ptychomitrium cucullatifolium** *(C. Müll.) Jaeg.* in Ber. Thätigk. St. Gallischen Naturwiss. Ges. 1872–1873: 104 (1874); Broth. in Natürl. PflFam., edn 2, 11: 9 (1925); Sim, Bryo. S. Afr. 215 (1926). Type: Cape, Witbergen, *Drège s.n.*, Jan. 1833 (BM!, G!, NY!).

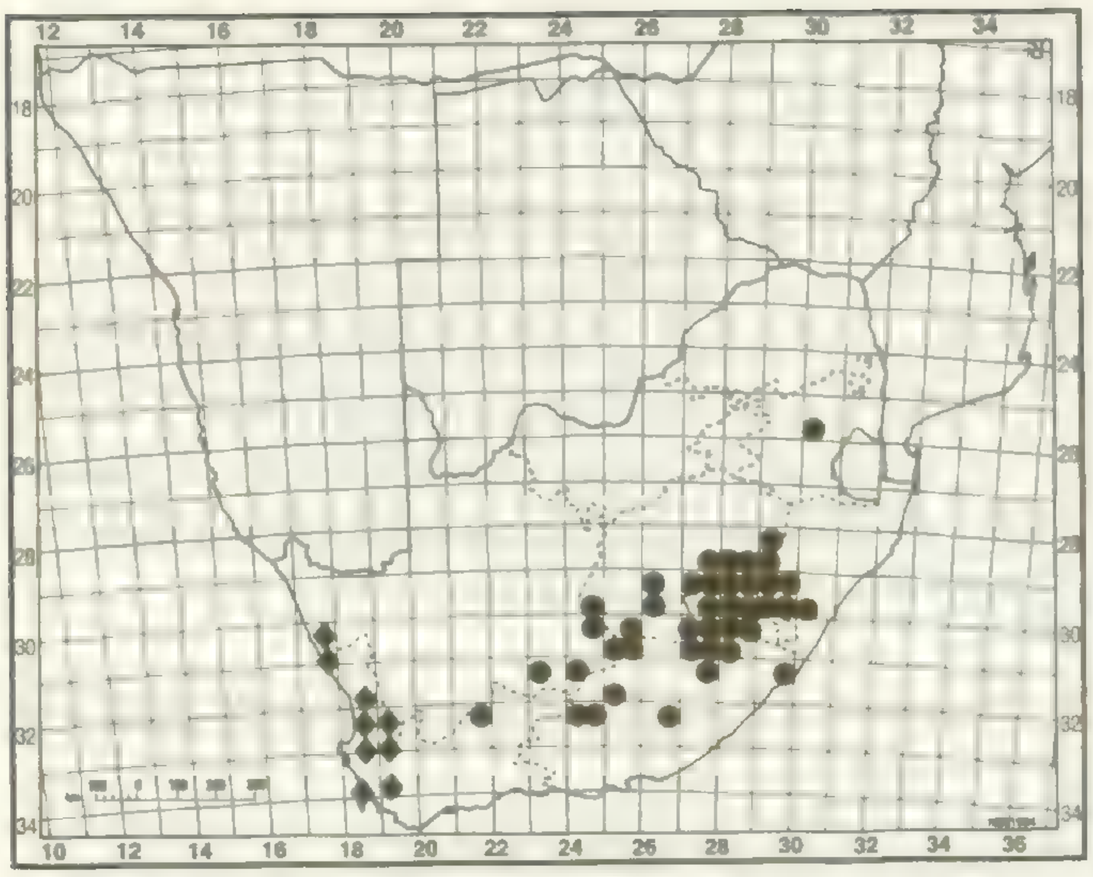
Ptychomitrium crispatum var. *brachycarpum* Hornsch. in Linnaea 15: 126 (1841). *Brachysteleum cucullatifolium* C. Müll., Syn. musc. frond. 1: 769 (1849). *Glyphomitrium cucullatifolium* (C. Müll.) Broth. in Natürl. PflFam. 1,3: 441 (1902); Dix. in Trans. Roy. Soc. South Africa 8: 196 (1920).

Brachysteleum obtusatum C. Müll. in Hedwigia 38: 122 (1899). *Ptychomitrium obtusatum* (C. Müll.) Par., Ind. bryol. suppl. 1: 289 (1900); Broth. in Natürl. PflFam., edn 2, 11: 9 (1925); Robinson in Bryologist 62: 229 (1963). *Glyphomitrium obtusatum* (C. Müll.) Broth. in Natürl. PflFam. 1,3: 441 (1902). Type: Transvaal, Middelburg to Lydenburg, *Wilms s.n.* (G, holo.!).

Plants medium-sized, caespitose, dark green to blackish green; terricolous or saxicolous. *Stems* (5–)10–20 mm high, occasionally branching above. *Leaves* weakly appressed and curved dry, erect-spreading wet; linear-lanceolate to ovate-lanceolate, (2.0–)2.5–3.0 mm long; bistratose above base; apex cucullate; margins occasionally multistratose. *Costa* percurrent to subpercurrent, smooth dorsally and ventrally; in section bulging dorsally, guide cells 8, distinct, ventral stereid band 2 cells thick, ventral surface cells distinct, slightly smaller than laminal cells, dorsal stereid band 3 cells thick, dorsal surface cells small, outer wall generally more strongly thickened. *Upper laminal cells* rounded-quadrate or ± transversely rectangular, 5–7(–10) µm, thickened; basal cells distinct, rectangular, thin-walled, yellowish.

Seta 2–3 mm long, yellow-brown. *Capsule* short-cylindrical, 1.2 mm long. *Peristome* teeth narrowly triangular, occasionally irregular, cleft, ornately papillose, yellowish. *Operculum* rostrate, 0.5 mm long. *Calyptra* mitrate, 2 mm long. *Spores* rounded, 11–14 µm, yellow-brown, granulate. Fig. 132: 6–12.

This species is known from Zimbabwe and southern Africa. In southern Africa over 95% of



MAP 185.— ● **Ptychomitrium cucullatifolium**
♦ **Ptychomitrium crassinervium**

the specimens have been collected on soil and rock in grassland in Lesotho, KwaZulu-Natal and the Free State, the remaining specimens in the eastern and central Cape regions (see note below). Map 185.

Vouchers: *Herman 606; Hilliard & Burtt 10463, 13615; Magill 4129, 4559, 5765; Smook 1117; Schelpe 2119; Van Rooy 412; Van Zinderen Bakker 448.*

Ptychomitrium cucullatifolium is very closely related to *P. crispatum*. Numerous specimens of *P. crispatum* are ± intermediate and difficult to place in one or the other species. However, almost all of these have been low-altitude collections with a subcucullate leaf apex and have here been placed in *P. crispatum*. Despite this apparent overlap, *P. cucullatifolium* has been maintained at the species level because these specimens have leaves consistently cucullate, leaf cells incrassate and are found predominantly in the southern Drakensberg.

The type specimen and a few recent collections have come from the Cape region. Since the holotype could not be examined (B), it is possible that the original gathering was a subcucullate form of *P. crispatum* and the Drakensberg plants represent an undescribed species. A specimen at Geneva (G!) marked 'Prom. Bon. Spei, Drège', however, conforms well with the concept of *P. cucullatifolium* presented here and has been accepted as part of the original gathering.

Ptychomitrium obtusatum has not been maintained although preliminary examination of the type showed an interesting difference in leaf shape, i.e., broader and less acuminate. Specimens referable to *P. obtusatum* appear to occur in isolated populations within the rather restricted range of *P. cucullatifolium*. Leaves of several specimens of *P. cucullatifolium* approach those of *P. obtusatum* and since there is little or no obvious difference in cell size, leaf length, spore or capsule characters, *P. obtusatum* is here regarded as a 'race' of *P. cucullatifolium*.

7. **Ptychomitrium crassinervium** *(C. Müll.) Schimp. ex Par.*, Ind. bryol. suppl. 1: 289 (1900); Broth. in Natürl. PflFam., edn 2, 11: 9 (1925); Sim, Bryo. S. Afr. 215 (1926). Type: Cape, Groenekloof, *Breutel s.n.*, 1862 (BM!).

Brachysteleum crassinervium C. Müll. in Hedwigia 38: 121 (1899). *Glyphomitrium crassinervium* (C. Müll.) Broth. in Natürl. PflFam. 1,3: 441 (1902); Dixon in Trans. Roy. Soc. South Africa 8: 196 (1920).

Plants small to medium-sized, caespitose, dark green to blackish green; terricolous. *Stems* 5–15 mm tall, little-branched. *Leaves* incurved and contorted above dry, erect-spreading wet; linear-lanceolate to ovate-lanceolate, (2.0–) 3.5–4.5 mm long; acute; bistratose; base weakly differentiated. *Costa* percurrent, wide below, smooth dorsally and ventrally; in section narrowly elliptical below, bulging dorsally above, guide cells 8–10, distinct, frequently with auxiliary cells, ventral stereid band 2 or 3 cells thick, ventral surface cells similar to ventral laminal cells, dorsal stereid band 4–6 cells thick, dorsal surface cells small and thickened proximally, similar to dorsal laminal cells distally. *Upper laminal cells* rounded-quadrate, 11–15 µm, larger juxtacostally, walls thickened, frequently somewhat irregularly so and producing ± wavy walls; ventral row ± larger than dorsal in section; basal cells short-rectangular, yellowish, thin-walled or weakly thickened.

Seta (2–)4–5 mm long, yellow-brown. *Capsule* short-elliptical, 1.5 mm long, brownish.

Peristome teeth linear, cleft and perforated, red-yellow, ornately papillose. *Operculum* rostrate, 1 mm long. *Calyptra* mitrate, 2 mm long. *Spores* rounded, 30–34 µm, greenish to brownish, weakly papillose. Fig. 132: 13–18.

Endemic to southern Africa, *P. crassinervium* is found on rocky soil of road cuttings, steep rocky slopes and clay banks in the western and southwestern Cape regions, Zimbabwe and Zambia. Map 185.

Vouchers: *Cholnoky 617; Esterhuysen 15655; Magill 3875, 4001; Oliver 7253, 7274.*

Ptychomitrium crassinervium can be confused with *P. crispatum*, but the following set of characters should separate the two species. The leaf cells of *P. crassinervium* are longer than 10 µm, the basal leaf cells are short-rectangular and little-thickened, and the costa is broader below and elliptical in transverse section, with surface cells large, thin-walled and distinct. In contrast, *P. crispatum* has leaf cells shorter than 10 µm, basal leaf cells long-rectangular, and a narrow costa which is round in transverse section with less clearly differentiated surface cells.

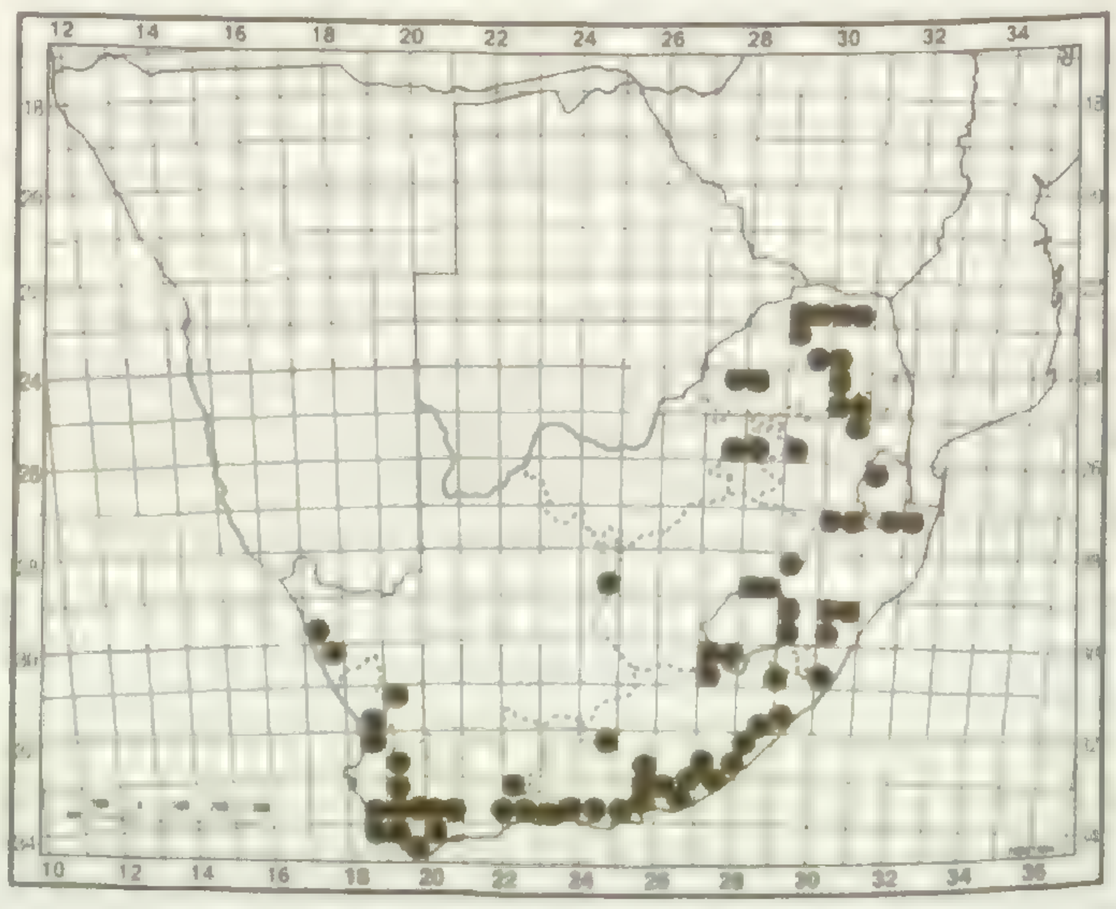
8. **Ptychomitrium crispatum** *(Hedw.). Jaeg.* in Ber. Thätigk. St. Gallischen Naturwiss. Ges. 1872–1873: 103 (1874); Broth. in Natürl. PflFam., edn 2, 11: 9 (1925); Sim, Bryo. S. Afr. 214 (1926). Type: Caput bonae spei, *Thunberg s.n.*

Encalypta crispata Hedw., Sp. musc. frond. 61 (1801). *Glyphomitrium crispatum* (Hedw.) Brid. Muscol. recent. suppl. 4: 30 (1818). *Orthotrichum crispatum* (Hedw.) Hook. & Grev. in Edinburgh J. Sci. 1: 115 (1824). *Brachypodium crispatum* (Hedw.) Brid., Bryol. univ. 1: 147 (1826). *Notarisia capensis* Hampe in Linnaea 11: 379 (1837), nom. illeg.

Plants medium-sized, caespitose, dark green, brownish below; saxicolous. *Stems* 10–20 mm long, occasionally branching above. *Leaves* incurved dry, widespreading wet; linear-lanceolate above short-oblong to elliptical base, (2.5–)3.0–5.0 mm long; bistratose; apex acute to subcucullate; lamina occasionally reflexed above a weakly appressed base. *Costa* percurrent, narrow; ventral superficial cells smooth, similar to ventral laminal cells; dorsal superficial cells smooth, rectangular, thickened; in section bulging dorsally (half-round throughout), guide cells 6, small, ventral stereid band 2 or 3 cells thick, ventral surface cells similar to laminal cells, dorsal stereid band (3–)5 or 6 cells thick, dorsal surface cells generally small, thickened, not clearly differentiated but becoming more pronounced distally. *Upper laminal cells* ± rounded-quadrate, somewhat variable, 5–8 µm, thickened; basal cells rectangular to rhomboidal, yellowish, thin-walled.

Seta (4–)5–8 mm long, yellowish. *Capsule* short-cylindrical, 1.5–2.0 mm long, yellow-brown, mouth red. *Peristome* teeth narrowly triangular, perforated, reddish yellow, ornately papillose. *Operculum* rostrate, 1 mm long. *Calyptra* mitrate, 2 mm long. *Spores* rounded, 12–16 µm, brownish, bluntly papillose. Fig. 132: 19–24.

The most widespread southern African species, *P. crispatum* has also been reported from eastern Africa, Madagascar, southern South America and the Juan Fernández islands. In the *Flora* area *P. crispatum* is found on rock, in rock crevices or shallow soil over rock in grassland or shrubland communities of the western, southwestern, central, southern and eastern Cape regions, the Free State, KwaZulu-Natal, Zululand, Swaziland and the central, eastern and northern Transvaal areas. Isolated specimens have also been collected in the northern Cape region and southern Lesotho. Map 186.



MAP 186.—**Ptychomitrium crispatum**

Vouchers: *Bayliss 8200; Ellis 3108; Garside 6712; Hardy 5421a; Magill 3657, 5991, 6111; Schelpe 7653; Van Zanten 760895.*

Variations in this rather widespread and somewhat plastic species reflect its relationship to *P. cucullatifolium* (p. 472), *P. depressum* (p. 469), and *P. crassinervium* (p. 473).

Another form of variation seen in specimens of *P. crispatum* involves irregularity in the bistratosity of the upper leaf lamina. Occasionally unistratose patches are present, but these are rarely as pronounced or extensive as in the leaves of *P. subcrispatum*. Specimens with multistratose margins are also occasionally encountered. These specimens can be confused with *P. subcrispatum*, especially if the leaves are not sectioned.

Insufficiently known species

Brachysteleum convolutifolium Shaw in Cape Monthly Mag. 17: 379 (1878). Syntypes: Cape, Graaff-Reinet, *McLea s.n.*; *Bolus s.n.*; *Shaw s.n.* Type material has not been seen and was apparently destroyed after Shaw's death. We would agree with Sim (1926) that the description is insufficient to place this species properly.

ORTHOTRICHACEAE

Plants small to large, forming mats or caespitose, variously green to brown; saxicolous, corticolous or terricolous. *Primary stem* prostrate or erect, variously branched; secondary stem horizontal or erect, frequently branching by subperichaetial innovations; in section subpentagonal to round, central strand absent or weak. *Leaves* appressed, erect, or variously twisted when dry, erect-spreading to squarrose when wet; variously ovate, lanceolate or oblong, rarely fragile above, occasionally rugulose to rugose; unistratose or bistratose or irregularly multistratose; apex variable; base rarely differentiated; margin plane, recurved or rarely incurved, entire, crenulate, denticulate or serrate above, rarely tuberculate below. *Costa* single, occasionally papillose or toothed dorsally. *Upper laminal cells* generally small, rounded, incrassate, flat to bulging, smooth, mammillose or papillose; basal cells generally rectangular to quadrate, smooth, papillose or tuberculate; alar cells not differentiated. *Gemmae* present or absent, filiform or clavate to subround.

Autoicous, dioicous or synoicous, occasionally pseudautoicous. *Perigonia* terminal, lateral or axillary. *Perichaetia* terminal on stems or branches. *Seta* short or long. *Capsule* immersed, emergent or exserted, frequently ribbed. *Peristome* absent, single or double, parts occasionally fused or reduced; exostome teeth 8, in 8 pairs or 16, outer plate thick, inner plate thin; endostome segments 8 or 16, alternating with teeth, not or weakly keeled, basal membrane low or absent, cilia absent. *Operculum* mostly conic-rostrate. *Calyptra* cucullate, mitrate or campanulate, frequently large, occasionally plicate, entire, lobed or lacerate below, naked or hairy. *Spores* granulate or papillose, isosporous or anisosporous.

A large and diverse family with ± 550 species in 14 genera of which 9 genera and 31 species occur in southern Africa. Members of the Orthotrichaceae are predominantly xerophytic and adapted to habitats on trees and rocks.

The family is characterized by leaves with small, incrassate and mostly papillose upper laminal cells, larger basal cells, no differentiated alar cells, a large calyptra and the generally diplolepidous peristome. The placement of genera with haplolepidous peristomes in the Orthotrichaceae is uncertain (Shaw 1986). The orthotrichaceous peristome is characterized by an exostome with the outer plate thicker than the inner plate and by the endostome segments generally alternating with the exostome teeth, segments not or weakly keeled, basal membrane and cilia absent, and frequently with a reduced number of inner peristomial layer divisions. Reduction of the peristome is frequently found in the family.

The Orthotrichaceae can be divided into four subfamilies of which three (Zygodontoideae, Orthotrichoideae and Macromitrioideae) occur in southern Africa.

Key to subfamilies and genera of the Orthotrichaceae

1 Primary stem erect, simple or sparsely branched; sporophytes produced on primary stem and branches; gemmae occasionally present; calyptra cucullate or mitrate:
2 Calyptra cucullate, naked or sparsely hairy (subfamily **Zygodontoideae**, p. 477):
3 Cells smooth or papillose; costa in cross section with median guide cells absent, ventral cells frequently larger; gemmae frequently present; capsule long-exserted; peristome absent, single or double . . . . . 1. **Zygodon**
3 Cells papillose to papillose-striolate; costa in cross section with median guide cells present; gemmae absent; capsule immersed or shortly exserted; peristome absent . . 2. **Amphidium**
2 Calyptra mitrate, hairy (subfamily **Orthotrichoideae**, p. 490):
4 Leaf base distinct, bordered . . . . . 5. **Ulota**
4 Leaf base indistinct, not bordered:

5 Leaves crispate dry; perichaetial leaves hyaline below . . . . . 4. **Stoneobryum**
5 Leaves erect to appressed or occasionally flexuose dry; perichaetial leaves chlorophyllous . . . . . 3. **Orthotrichum**

1 Primary stem prostrate, with numerous horizontal or erect branches; sporophytes produced on secondary stem and branches; gemmae absent; calyptra mitrate (subfamily **Macromitrioideae**, p. 506):
6 Branch leaves secund, base decurrent, cells tuberculate . . . . . 9. **Cardotiella**
6 Branch leaves appressed, flexuose, twisted or inrolled, base not decurrent:
7 Branches slender, widely spaced; branch leaves appressed dry; basal cells scarcely differentiated, short . . . . . 6. **Macrocoma**
7 Branches with a bushy appearance, crowded; branch leaves flexuose to variously twisted or inrolled dry; basal cells differentiated, elongate:
8 Leaves flexuose, twisted to contorted or inrolled dry; calyptra plicate, naked or sparsely hairy, laciniate or lacerate below . . . . . 7. **Macromitrium**
8 Leaves twisted to spirally twisted around stem dry; calyptra smooth, naked, lobed below . . . . . 8. **Schlotheimia**

Subfamily ZYGODONTOIDEAE

Plants small to large; saxicolous, terricolous or corticolous. *Primary stems* erect, simple or sparsely branched. *Leaves* appressed, twisted or crisped when dry; narrowly lanceolate or oblong to elliptical; base scarcely differentiated. *Upper laminal cells* rounded or rounded-hexagonal, incrassate, smooth or papillose or striolate-papillose; basal cells mostly rectangular. *Gemmae* frequently present on stems or rhizoids.

Perichaetia terminal on primary stem and branches. Dwarf male plants absent. *Capsule* immersed, short-exserted or long-exserted; ribbed. *Stomata* phaneropore. *Peristome* absent or single or double. *Calyptra* cucullate, naked or sparsely hairy. Isosporous.

1. ZYGODON

Zygodon *Hook. & Tayl.*, Muscol. brit. 70 (1818); Broth. in Natürl. PflFam., edn 2, 11: 11 (1925); Sim, Bryo. S. Afr. 268 (1926); Malta, Die Gattung *Zygodon* 1–184 (1926); Sainsb., N. Zeal. mosses 198 (1955); Scott & Stone, Moss. S. Austr. 245 (1976); Gangulee, Moss. E. India 5: 1153 (1976); Smith, Moss Fl. Brit. Irel. 470 (1978); Crum & Anderson, Moss. E.N. Amer. 2: 679 (1981). Type species: *Z. conoideus* (Dicks.) Hook. & Tayl.

Plants small to large, loosely caespitose to caespitose; corticolous or saxicolous to terricolous. *Stems* erect, in section pentagonal to round, epidermis not differentiated. *Leaves* ± crowded, erect to appressed or twisted when dry, erect-spreading to squarrose and frequently reflexed to recurved when wet, occasionally in 5 indistinct rows, frequently rugulose; variously lanceolate or oblong to elliptical; apex acute, acuminate, rounded-acute to obtuse or occasionally mucronate or apiculate, frequently toothed; base scarcely differentiated, decurrent; margins plane or undulate, entire or crenulate or serrate. *Costa* ending below apex, percurrent, subpercurrent or merging with elongated apical cells to become mucronate or apiculate. *Upper laminal cells* small, irregularly rounded-hexagonal, incrassate, smooth or papillose; basal cells quadrate to rectangular or rhomboidal, smooth or papillose. *Gemmae* frequently produced on stem or rhizoids, uniseriate or multicellular, generally reddish brown.

Dioicous, autoicous or synoicous. Inflorescence terminal, overgrown by innovations, perichaetial leaves scarcely differentiated, perigonial leaves and leaves of synoicous inflorescence differentiated. *Seta* long, twisted anticlockwise above. *Capsule* erect, elliptical, oblong-cylindrical or narrowly pyriform, 8-ribbed or plicate; mouth occasionally 3- or 4-sulcate, infrequently strongly thickened; neck differentiated; stomata on neck, phaneropore. *Peristome* absent, single or double. *Operculum* short- to long-conic-rostrate, straight to oblique. *Calyptra* cucullate, naked or sparsely hairy. *Spores* round, ± granulate, brownish.

A genus of ± 90 species found mostly in tropical to temperate regions of the southern hemisphere. Tropical South America is the major centre of described species. In southern Africa most species are found on stems and branches of trees or on soil and rock in montane forests and woodlands of northern and eastern Transvaal, KwaZulu-Natal, and the southern and eastern Cape regions. Two species occur in the Fynbos Biome of the southwestern Cape.

Zygodon is recognized by the tall plants with twisted to secund or erect to appressed leaves when dry, small and frequently papillose leaf cells, long-exserted, ribbed or plicate capsule, cucullate calyptra, and numerous gemmae produced on rhizoids and in leaf axils.

1 Leaf cells smooth, margin entire; autoicous . . . . . 1. *Z. dixonii*
1 Leaf cells papillose or smooth, margin serrate; dioicous or synoicous:
  2 Leaf margin serrate; upper costa frequently with multicellular teeth dorsally; peristome double; southwestern Cape region . . . . . 2. *Z. runcinatus*
  2 Leaf margin entire, crenulate or rarely with a single tooth above; costa smooth; peristome single or absent; Transvaal regions, KwaZulu-Natal, eastern, southern and southwestern Cape regions:
    3 Gemmae with transverse and longitudinal septa . . . . . 6. *Z. erosus*
    3 Gemmae with transverse septa only:
      4 Leaf apex rounded-acute to rounded-obtuse, costa merging with apical cells to become mucronate; capsule mouth sulcate when dry; peristome absent; calyptra hairy . . . . . 5. *Z. trichomitrius*
      4 Leaf apex acute to acuminate, costa ending below apex; capsule mouth thickened, erect when dry; peristome single, endostome segments fragile; calyptra naked:
        5 Plants dioicous; Transvaal regions, KwaZulu-Natal and eastern Cape . . . 3. *Z. intermedius*
        5 Plants synoicous; southwestern Cape region . . . . . 4. *Z. leptobolax*

1. **Zygodon dixonii** *Sim*, Bryo. S. Afr. 271 (1926). Type: Natal, below Cathkin Peak, *Sim 10004* (PRE, holo.!).

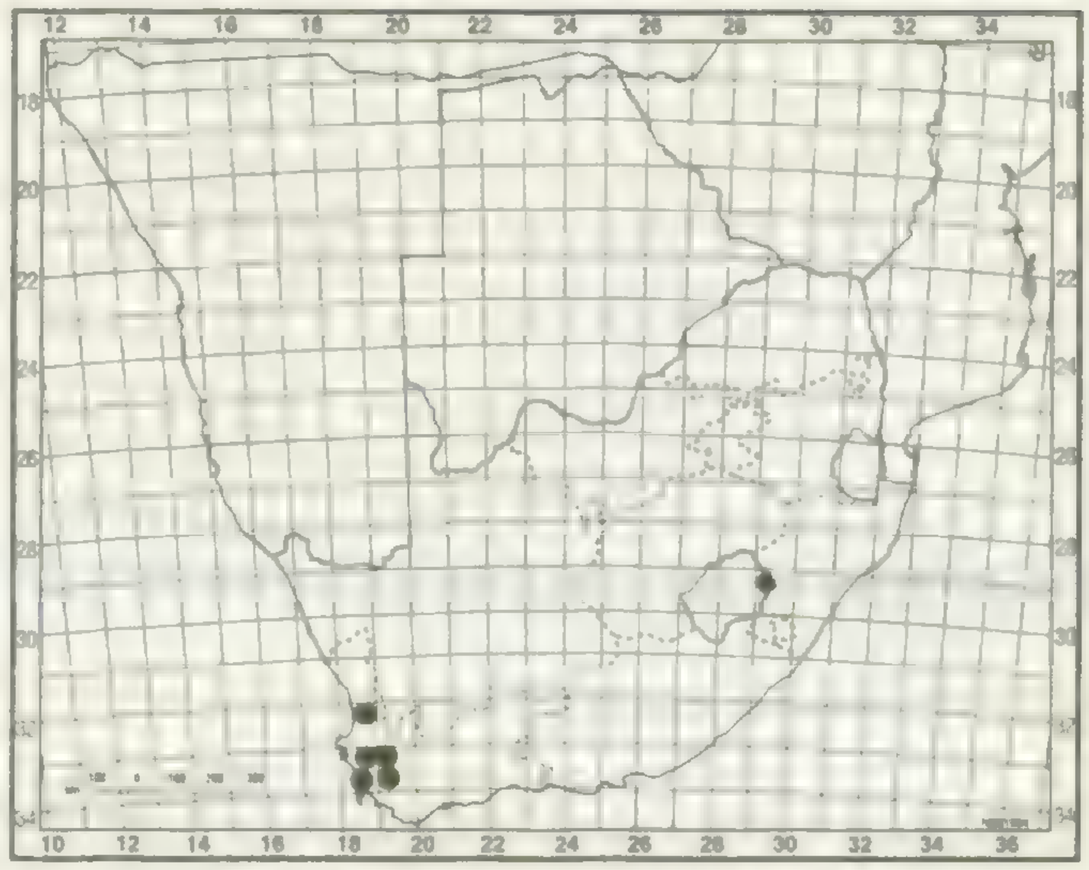
Plants small, caespitose, yellowish green above, reddish brown below; saxicolous. *Stems* up to 8 mm tall, branching by subperichaetial innovations, tomentose below; rhizoids smooth to coarsely papillose, reddish brown or pale brown; in section round, cortical cells in 10 rows, inner cells thin-walled, gradually smaller and incrassate towards outer cells, outer cells bulging. *Leaves* ± equal in size to larger above, twisted when dry, erect-spreading when wet; narrowly oblong, 1.0–1.6 mm long, ventral surface keeled; apex mucronate or apiculate; base scarcely differentiated, margins decurrent; margins plane or occasionally recurved below, entire, unistratose. *Costa* subpercurrent to percurrent; ventral and dorsal superficial cells rectangular to linear, incrassate; in section round, bulging dorsally, lamina ventrally inserted, not differentiated or 2 guide cells exposed ventrally, ventral stereid band absent, dorsal stereids in 2 or 3 rows, dorsal surface cells not differentiated, rough. *Upper laminal cells* rounded-hexagonal, flat, smooth, (8–)10–12(–17) µm; basal cells large, reaching higher along costa, quadrate to rectangular, thin-walled to incrassate, smooth. *Gemmae* absent.

Autoicous. *Perigonia* subperichaetial on short branches, gemmate, leaves ovate. *Perichaetia* terminal, leaves not differentiated. *Seta* 3.0–4.5 mm long, brownish. *Capsule* exserted, erect, elliptical or narrowly pyriform, brownish, 8-ribbed, urn 0.7–1.0 mm long, neck 0.5 mm long; exothecial cells rectangular to quadrate, thin-walled, longitudinal walls of rib cells incrassate, smaller and rounded at mouth, incrassate; annulus deciduous. *Peristome* double; exostome teeth in 8 pairs, recurved when dry, narrowly lanceolate, fused below, perforated above, 230–310 µm long, densely papillose to striolate-papillose, yellowish brown; endostome segments alternating with teeth pairs, shorter than teeth, erect when dry, linear-lanceolate, papillose-striolate, hyaline, basal membrane low. *Operculum* 0.5 mm long, oblique. *Calyptra* 1.3 mm long, naked, cells prorate above. *Spores* 11–15 µm. Fig. 133: 1–13.

Known only from the type locality in the Drakensberg of KwaZulu-Natal. Map 187.

Voucher: type only.

The small plants and smooth leaf cells separate *Z. dixonii* from other *Zygodon* species in southern Africa.



MAP 187.— ♦ **Zygodon dixonii**
● **Zygodon runcinatus**

2. **Zygodon runcinatus** *C. Müll.* in Hedwigia 38: 114 (1899); Broth. in Natürl. PflFam., edn 2, 11: 15 (1925); Sim, Bryo. S. Afr. 268 (1926); Malta, Die Gattung *Zygodon* 109 (1926). Isosyntypes: Cape, Table Mountain, *Rehmann 150*; Devil's Peak, *Rehmann 150b* (both PRE!).

Plants medium-sized, caespitose, yellowish green or olivaceous above, brown to dark brown below; saxicolous to terricolous. *Stems* to 40 mm tall, branching dichotomously or by subperichaetial or subperigonial innovations, sparsely tomentose below; rhizoids smooth to coarsely papillose, red-brown or red; in section pentagonal to subround, inner cortex 7–14 cells across, thin-walled to incrassate, smaller towards outside, outer cortical cells smaller, in 1–4 rows, substereids or stereids. *Leaves* ± crowded, ± equal in size, erect to appressed when dry, widespreading to squarrose-recurved from ± sheathing bases when wet, in 5 indistinct rows, spiralled around stem; ovate-lanceolate to lanceolate or oblong-lanceolate, 1.4–3.0(–3.6) mm long; ventral surface keeled; apex acute to acuminate, toothed; base ovate to oblong, ± sheathing, margins decurrent; margins plane, serrate to strongly serrate in upper half to two-thirds, teeth frequently multicellular, unistratose with bistratose patches, thickened. *Costa* ending below apex to subpercurrent, ventral and dorsal superficial cells rounded to elongate, incrassate; in section round, bulging dorsally, lamina ventrally inserted, not differentiated or 2–4 ventral guide cells larger, ventral stereid band absent, dorsal cells in 1–3 rows, incrassate to stereids, with dorsal teeth distally, teeth multicellular. *Upper laminal cells* small, irregularly rounded-hexagonal, flat, (7.0–)8.5–12.5(–14.0) µm, smooth to papillose, 1–4 papillae scattered over lumen, small, low; basal cells rhomboidal to rectangular, thin-walled to incrassate, smooth or walls papillose. *Gemmae* axillary, subclavate, uniseriate, with transverse septa.

Dioicous. *Perigonia* terminal, leaves broadly ovate to orbicular. *Perichaetia* terminal; inner leaves oblong-acuminate or ovate-acuminate to lanceolate, 1.2–2.5(–2.8) mm long; apex acuminate; margins plane, entire to crenulate above; costa frequently weak, ending below apex; lami-

nal cells rounded to vermiculate above, vermiculate below, occasionally papillose. *Seta* 3–5 mm long, yellowish or brownish. *Capsule* exserted, erect, elliptical or narrowly pyriform, 8-ribbed, urn 1.0–1.8 mm long, neck 0.3–0.6 mm long; exothecial cells rectangular to quadrate, irregularly incrassate, smaller at mouth, rounded-quadrate, cells of ribs differentiated; annulus deciduous. *Peristome* double, recurved when dry; exostome teeth in 8 pairs, narrowly triangular or lanceolate, fused below, perforated above, 180–300 µm long, densely papillose above, striolate-papillose below, yellowish or yellowish brown; endostome segments alternating with teeth pairs, linear, minutely papillose or smooth, pale yellow or hyaline, basal membrane low or absent. *Operculum* 0.5 mm long, oblique. *Calyptra* 2.5–3.0 mm long, smooth, naked. *Spores* 15.0–22.5 µm. Fig. 133: 14–26.

The species is known from the Fynbos Biome of the southwestern Cape region and from Tanzania. Map 187.

Vouchers: *Barnard PRE-CH3405, PRE-CH6032; Esterhuysen 16594; Garside 6619; Magill & Schelpe 3967, 3998; Schelpe 4969; Thorne PRE-CH6416.*

Zygodon runcinatus is easily recognized by the strongly serrate leaf margins and the multicellular teeth on the dorsal side of the upper costa.

3. **Zygodon intermedius** *B.S.G.*, Bryol. eur. 3: 41 (1838); Broth. in Natürl. PflFam., edn 2, 11: 15 (1925); Malta, Die Gattung *Zygodon* 75 (1926); Lewinsky in Lindbergia 15: 131 (1990). Type: New Zealand, Dusky Sound, *Menzies 66* (BM, holo.).

Zygodon transvaalensis Rehm. ex Sim, Bryo. S. Afr. 271 (1926). Type: Transvaal, in mont. Lechlaba ad arborum truncos, *Rehmann 500* (PRE, iso.!).

Plants small to medium-sized, loosely caespitose to caespitose, yellowish green to brown; terricolous or corticolous. *Stems* up to 25 mm tall, branching by innovations, tomentose below; rhizoids smooth to papillose or granulose, reddish brown or reddish; in section subpentagonal or round, central strand absent, inner cortex 5–10 cells across, thin-walled to incrassate, outer cortical cells smaller, in 1–3 rows, incrassate or with substereids to stereids, outer cells frequently rough. *Leaves* ± crowded, ± equal in size or larger above, twisted or secund and ± appressed when dry, erect-spreading to squarrose and recurved when wet; narrowly oblong-lanceolate to lanceolate or occasionally oblong to elliptical, 0.6–2.5 mm long, ventral surface keeled to broadly keeled; apex acute to acuminate, occasionally apiculate, with a single clear tooth; base scarcely differentiated, decurrent; margins ± undulate above, rarely recurved below, entire or rarely with a single tooth above, entire to crenulate below, unistratose. *Costa* ending below apex; ventral and dorsal superficial cells long-rectangular to linear; in section subround to round, bulging dorsally, guide cells exposed ventrally, dorsal stereid band 1–3 cells thick, dorsal surface cells not differentiated, ± rough. *Upper laminal cells* irregularly rounded-hexagonal, flat, 7.5–15.0 µm, papillose to densely papillose, papillae 4–7, scattered over lumen, low and blunt; basal cells short-rectangular to quadrate, thin-walled to incrassate or transverse walls incrassate, smooth or with a single papilla over lumen or walls papillose. *Gemmae* produced on stem, filiform or clavate, uniseriate, with transverse septa, (2)3–5 cells long, reddish brown.

Dioicous. *Perigonia* and *perichaetia* terminal, quickly overgrown by innovations; perigonial leaves shortly ovate-apiculate or ovate-

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FIG 133.—**Zygodon dixonii** (1–13): **1.** habit, (dry), × 5; **2.** habit (wet), × 7; **3.** stem in cross section, × 175; **4.** leaf, × 35; **5.** leaf in cross section, × 175; **6.** basal leaf cells (right side), × 175; **7.** upper laminal cells, × 350; **8.** leaf apex, × 175; **9.** stoma of capsule wall, × 350; **10.** part of capsule mouth with peristome, × 175; **11.** operculum, × 70; **12.** calyptra, × 35; **13.** spores, × 700. **Z. runcinatus** (14–26): **14.** habit (dry), × 3; **15.** habit (wet), × 4; **16.** stem in cross section, × 175; **17.** leaf, × 35; **18.** leaf in cross section, × 175; **19.** basal leaf cells (right side), × 175; **20.** laminal cells at left margin, × 700; **21.** cells at leaf apex, × 175; **22.** gemma, × 350; **23.** perichaetial leaf, × 35; **24.** part of capsule mouth with peristome, × 175; **25.** operculum, × 70; **26.** spore, × 700. (14, 20, 23, 24 & 26, *Barnard 50331*; 15, *Esterhuysen 16594*; 16 & 18, *Barnard 44154*; 17 & 21, *Thorne 6416*; 19, *Garside 6619*; 22, *Rehmann 150*; 25, *Sim 9398*.)

FIG. 134.—**Zygodon trichomitrius** (1–11): **1.** habit (dry), × 2; **2.** habit (wet), × 3; **3.** leaf, × 35; **4.** leaf cross section, × 175; **5.** basal leaf cells, × 350; **6.** upper laminal cells, × 350; **7.** cells at leaf apex, × 350; **8.** gemma, × 350; **9.** part of capsule mouth, × 175; **10.** calyptra, × 18; **11.** spore, × 700. **Z. erosus** (12–23): **12.** habit (dry), × 1; **13.** habit (wet), × 2; **14.** leaf, × 35; **15.** leaf cross section, × 175; **16.** basal leaf cells, × 350; **17.** upper laminal cells, × 350; **18.** leaf apex, × 350; **19.** gemma, × 175; **20.** filamentous gemmae at leaf base, × 175; **21.** part of capsule mouth, × 175; **22.** calyptra, × 18; **23.** spore, × 700. **Z. intermedius** (24–34): **24.** habit (dry), × 1; **25.** habit (wet), × 3; **26 & 27.** leaves, × 35; **28.** leaf cross section, × 175; **29.** basal leaf cells, × 350; **30.** upper laminal cells, × 700; **31.** leaf apex, × 350; **32.** gemma, × 350; **33.** perichaetial leaf, × 35; **34.** part of capsule mouth, × 175; **35.** calyptra, × 35. (12, 18, 21–23, *Sim 10045*; 13, *Sim 10070*; 14, 19 & 20, *Stirton 8991*; 15, *Magill 5508*; 16, *Magill 5527*; 17, *Van Rooy 1629*; 24, 29 & 32, *Van Rooy 1508*; 25 & 35, *Magill 5667*; 26, *Sim 10030*; 27, *Sim 10101*; 28, *Jacot Guillarmod PRE-CH12583*; 30, *Sim PRE-CH7579*; 31 & 34, *Magill 5662*; 33, *Magill 5684*.)

acuminate; perichaetial leaves scarcely differentiated. *Seta* 5–10 mm long, brownish. *Capsule* oblong-cylindrical or narrowly pyriform, 1.5–2.2 mm long, brownish, 8-ribbed, neck differentiated; exothecial cells quadrate to short-rectangular, incrassate, smaller at mouth; annulus apparently absent. *Peristome* fragile, exostome teeth rudimentary; endostome segments distant, ± linear, irregular in outline, 85–105 µm long, yellowish, essentially smooth, basal membrane absent. *Operculum* 0.8 mm long, ± oblique. *Calyptra* 2.0–2.5 mm long, smooth. *Spores* 17–25 µm. Fig. 134: 24–34.

Zygodon intermedius frequently grows on bark of trees but has also been found on soil. This pantropical species has been reported from Australasia, tropical Asia, South America, the Juan Fernández islands, sub-Saharan Africa and the Mascarenes. In the *Flora* area it is known from montane forests in the northern and eastern Transvaal regions, KwaZulu-Natal, the eastern Cape region, and from cliffs at Sani Pass, KwaZulu-Natal. Map 188.

Vouchers: *Crosby 7927; Magill 4471, 5662, 5684, 7323; Sim 10101; Van Rooy 1505.*

The dioicous sexual condition and geographical distribution separate *Z. intermedius* from the very similar *Z. leptobolax* (see note below).

4. **Zygodon leptobolax** *C. Müll.* in Hedwigia 38: 113 (1899); Broth. in Natürl. PflFam., edn 2, 11: 14 (1925); Sim, Bryo. S. Afr. 270 (1926); Malta, Die Gattung *Zygodon* 130 (1926). Type: Cape, Cape Town, Rondebosch, *Rehmann 499* (PRE, iso.!).

Plants small to medium-sized, loosely caespitose, yellowish brown to brown; corticolous. *Stems* up to 11 mm tall, branching by innovations, tomentose below; rhizoids smooth to papillose, reddish brown; in section subpentagonal to round, central strand absent, inner cortex 3–6 cells across, thin-walled or incrassate towards outside, outer cortical cells smaller, in 1–3 rows, consisting of substereids, outer cells occasionally rough. *Leaves* ± crowded, slightly larger above, twisted to secund and ± appressed when dry, erect-spreading when wet; oblong-lanceolate to lanceolate, 0.7–2.0 mm long; ventral surface broadly keeled; apex acute to acuminate, with a single clear tooth above; base scarcely differentiated, decurrent; margins ± undulate above, plane or rarely recurved below, entire or rarely with a single blunt tooth above, entire to crenulate below, unistratose. *Costa* ending below apex; ventral and dorsal superficial cells long-rectangular to linear; in section subround, bulging dorsally, guide cells exposed ventrally, dorsal stereid band 1–3 cells thick, dorsal surface cells ± rough. *Upper laminal cells* irregularly rounded-hexagonal, 11–17(–20) µm, papillose to densely papillose, frequently obscured by papillae, 4–7 papillae scattered over lumen, low and blunt; basal cells short-rectangular to quadrate, incrassate, smooth or with single papilla over lumen or walls papillose. *Gemmae* produced on stem, subclavate, uniseriate with transverse septa, 3 or 4 cells long, reddish brown.

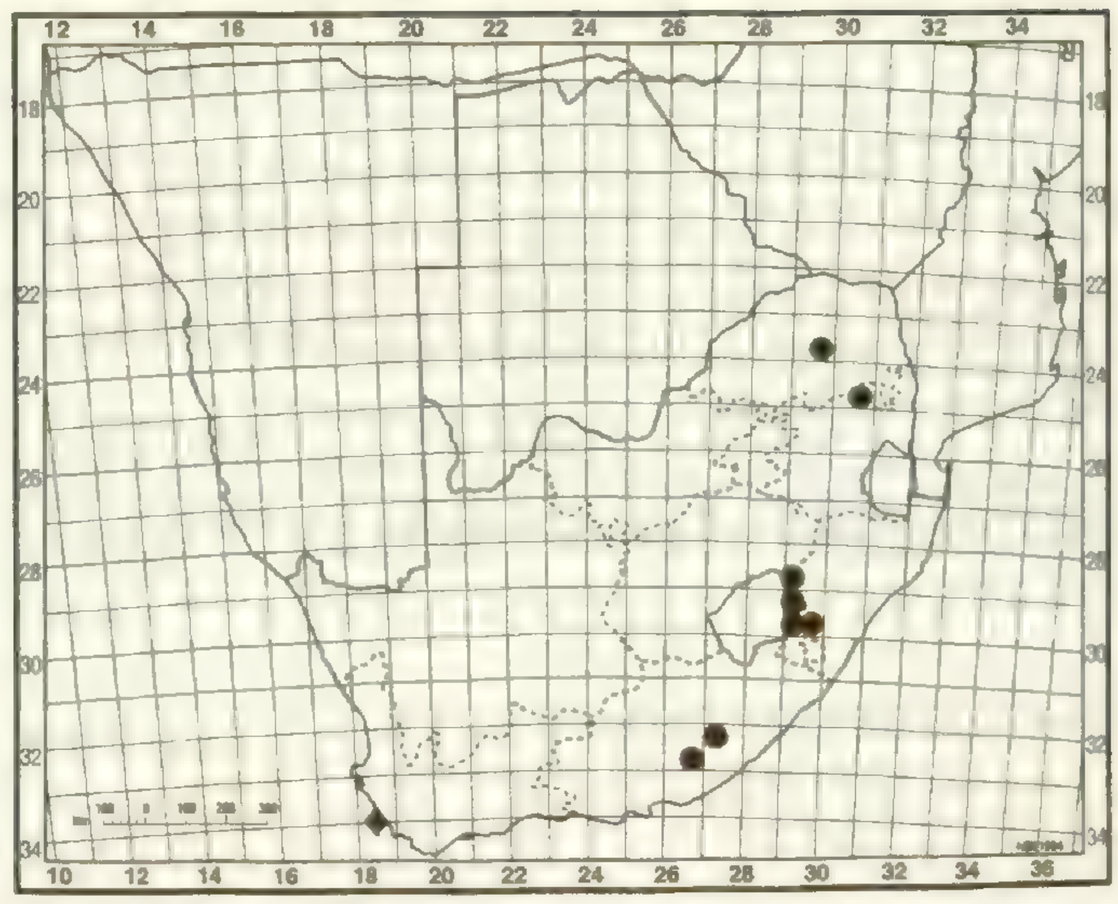
Synoicous. Inflorescence terminal; leaves broadly ovate-acuminate to oblong-acuminate, 0.5–1.3 mm long. *Seta* 4.5–10.0 mm long, reddish brown. *Capsule* oblong-cylindrical or narrowly pyriform, 1–2 mm long, 8-ribbed, neck differentiated; exothecial cells quadrate to rectangular, longitudinal walls incrassate along ribs, smaller and incrassate at mouth; annulus apparently absent. *Peristome* fragile, exostome absent; endostome segments short, distant, yellowish, basal membrane absent. *Operculum* 0.6–0.8 mm long. *Calyptra* 1.8–2.0 mm long, smooth. *Spores* 17–28 µm. Fig. 135.

This is another species of *Zygodon* restricted to the Fynbos Biome of the southwestern Cape region where it was collected from bark on the slopes of Table Mountain. Map 188.

Vouchers: *Rehmann 148; Sim 9150.*

In the absence of the synoicous inflorescence *Z. leptobolax* is practically indistinguishable from similar specimens of *Z. intermedius*. The two species are characterized by the falcate stems, twisted to secund and frequently appressed leaves, acute to acuminate leaf apex with a single clear tooth above, wavy leaf margins, costa ending below the apex, uniseriate

FIG. 135.—**Zygodon leptobolax**: **1.** habit (dry), × 3; **2.** habit (wet), × 5; **3.** leaf, × 35; **4.** leaf apex, × 350; **5.** gemma, × 350; **6.** part of synoicous inflorescence, × 70; **7.** leaf of synoicous inflorescence, × 35. (1, 2, 4 & 7, *Rehmann 499*; 3, *Rehmann 148*; 5 & 6, *Sim 9150*.)



MAP 188.— ● **Zygodon intermedius**
♦ **Zygodon leptobolax**

gemmae, thickened capsule mouth, and the single peristome with endostome segments distant and reduced.

5. **Zygodon trichomitrius** *Hook. & Wilson* in London J. Bot. 5: 143 (1846); Broth. in Natürl. PflFam., edn 2, 11: 14 (1925); Sim, Bryo. S. Afr. 269 (1926); Malta, Die Gattung *Zygodon* 62 (1926). Type: Cape, on trees in the forest of Grootvadersbosch, Swellendam district, *Zeyher s.n.* (BM-Hook., lecto.!, selected here).

Plants medium-sized to large, loosely caespitose to caespitose, yellowish green or light green to green above, olivaceous or yellowish brown to brown below; corticolous. *Stems* frequently falcate above, up to 40 mm tall, branching by subperichaetial or subperigonial innovations, sparsely tomentose to tomentose below; rhizoids smooth to coarsely papillose, reddish brown to red; in section subpentagonal or subround, inner cortex 7–11 cells across, thin-walled, incrassate towards outside, outer cortical cells smaller, in 2–4 rows, consisting of substereids or stereids. *Leaves* ± crowded, ± equal in size to larger above, twisted or contorted when dry, widespreading to squarrose and recurved when wet, infrequently rugulose, in 5 indistinct rows, spiralled around stem; narrowly oblong-lanceolate or lanceolate, (1.7–)2.0–3.4 (–3.7) mm long; ventral surface keeled; apex acute to rounded-acute to rounded-obtuse, mucronate, cells of mucro fusiform, smooth, incrassate, with single tooth; base scarcely differentiated, ± sheathing, margins decurrent; margins plane, generally crenulate, unistratose. *Costa* merging with elongated cells of mucro, ventral and dorsal superficial cells long-rectangular to linear; in section subround, bulging dorsally, lamina ventrally inserted, 2–4 guide cells exposed ventrally, ventral stereid band absent, dorsal stereid band 1–3 cells thick, dorsal surface cells not differentiated, rough. *Upper laminal cells* irregularly rounded-hexagonal, flat, 7.5–15 µm, papillae low, blunt, scattered; basal cells rhomboidal to rectangular, thin-walled to incrassate, smooth or with single papilla over lumen or papillose along walls. *Gemmae* numerous, on stem, subclavate, uniseriate with transverse septa, 3–5 cells long, reddish brown.

Dioicous. *Perigonia* terminal, quickly overgrown by subperigonial innovation; leaves broadly ovate, ovate-apiculate or shortly ovate-acuminate. *Perichaetia* terminal; leaves scarcely differentiated, inner leaves occasionally linear from a lanceolate base, shorter, 1.2–2.8 mm long, apex acuminate. *Seta* 8.5–11.0 mm long, brownish. *Capsule* narrowly pyriform, brownish, plicate, mouth 3- or 4-sulcate when dry, orange to brown, urn 1.4–2.0 mm long, neck 0.5–0.8 mm long; exothecial cells irregularly quadrate to rectangular, smaller at mouth, longitudinal walls incrassate above; annulus apparently absent. *Peristome* absent. *Operculum* 1.0–1.5 mm long, straight to oblique. *Calyptra* 2.6–3.0 mm long, sparsely hairy, hairs uniseriate, ascending, smooth to crenulate, cells occasionally prorate distally above. *Spores* 17–20 µm. Fig. 134: 1–11.

The typical variety of *Z. trichomitrius* is endemic to southern Africa. The var. *mildbraedii* (Broth.) Malta is found in central and eastern Africa (Malta 1926). In the *Flora* area the species is found on trunks, branches and exposed roots of trees and rarely on rock in forests of the northern and eastern Transvaal regions, KwaZulu-Natal and the eastern, southern and southwestern Cape regions. Map 189.

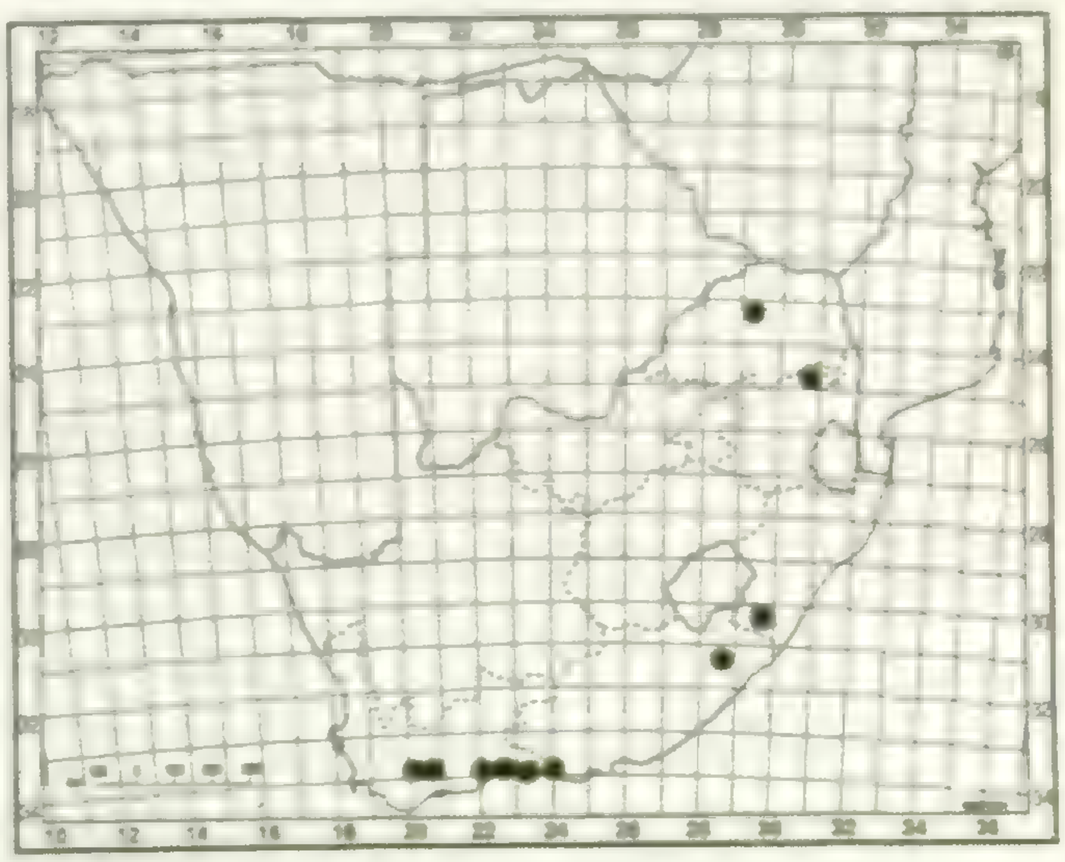
Vouchers: *Crosby & Crosby 7634; Magill 3749, 5956, 6217; Schelpe 7869a; Van Rooy 2285, 2296.*

The recurved leaves, relatively broad above with rounded-acute to rounded-obtuse apices and mucronate costae, the uniseriate gemmae, and gymnostomous capsule with sulcate mouth place plants in this species. For differences between *Z. trichomitrius* and *Z. erosus*, see p. 486.

6. **Zygodon erosus** *Mitt.* in J. Linn. Soc., Bot. 22: 305 (1886); Broth. in Natürl. PflFam., edn 2, 11: 15 (1925); Malta, Die Gattung *Zygodon* 63 (1926). Type: Tanzania, Kilimanjaro. *Hannington s.n.* (NY, holo.!).

Zygodon africanus Sim, Bryo. S. Afr. 270 (1926). Type: Transvaal, MacMac, *MacLea* sub *Rehmann 497* (PRE!).

Plants medium-sized to large, caespitose, yellowish green to green above, yellowish brown to brown below; corticolous. *Stems* up to 50 mm tall, branching dichotomously or by subperichaetial or subperigonial innovations, tomentose below, rhizoids smooth to coarsely papillose, reddish brown to red, in section weakly pentagonal to subround, inner cortex 6–12 cells across, thin-walled, outer cortical cells smaller, in 2–4 rows, incrassate or consisting of stereids. *Leaves* crowded, ± equal in size to larger above, twisted or contorted when dry, erect-spreading to squarrose and reflexed to recurved when wet, frequently rugulose, frequently in 5 indistinct rows, spiralled around stem; narrowly ovate-lanceolate to oblong-lanceolate or linear-lanceolate, 1.9–3.6 mm long; ventral surface keeled; apex acuminate, acute or occasionally obtuse, apiculate, cells of apiculus elongate, smooth, incrassate, frequently with single tooth; base scarcely differentiated, ± sheathing, margins decurrent; margins plane, generally crenulate, unistratose. *Costa* ending below apex or merging with elongated cells of apiculus; ventral and dorsal superficial cells long-rectangular to linear; in section subround, bulging dorsally, lamina ventrally inserted, 2 guide cells exposed ventrally, ventral stereid band absent, dorsal stereid band 1–4 cells thick, dorsal surface cells not differentiated, rough. *Upper laminal cells* irregularly rounded-hexagonal, ± flat,



MAP 189.—**Zygodon trichomitrius**

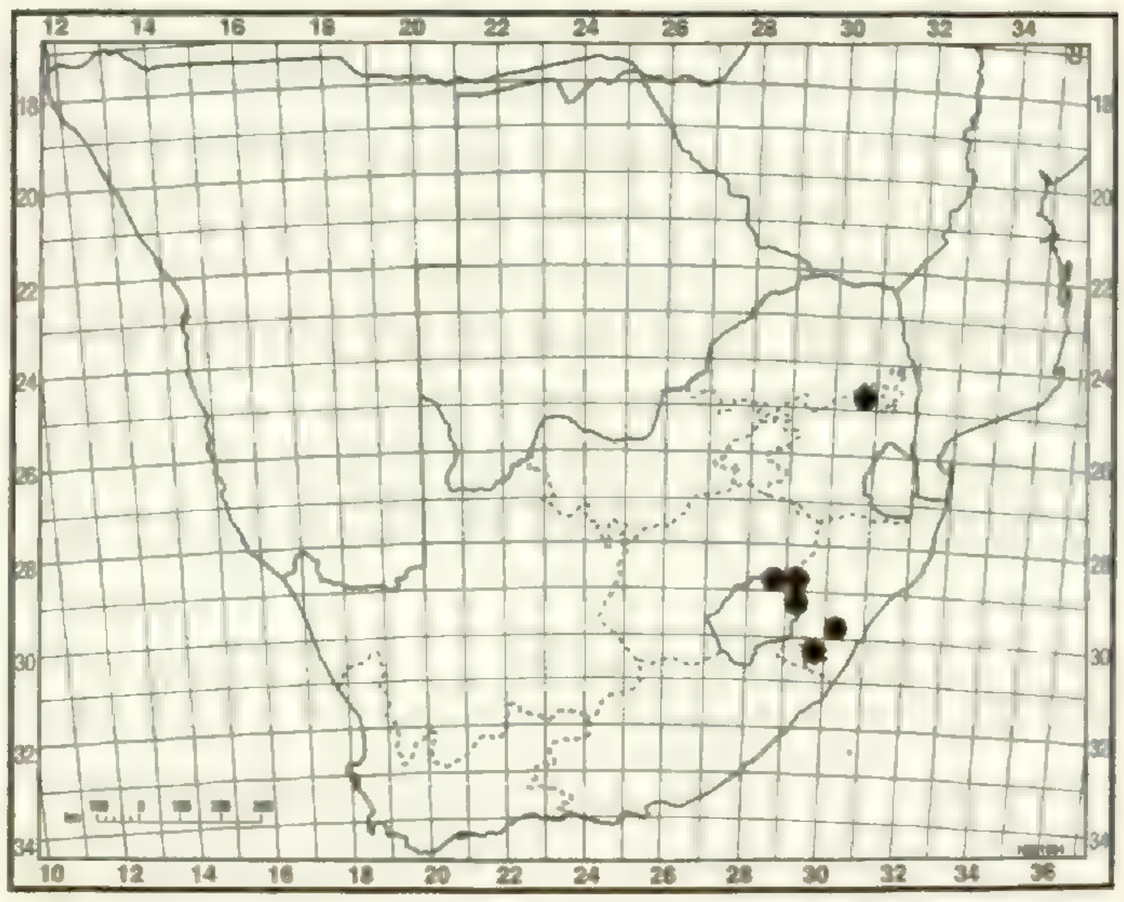
8.5–12.5(–15.0) µm, papillae low, scattered; basal cells rectangular, thin-walled to incrassate, smooth or walls papillose, occasionally reaching higher along costa. *Gemmae* numerous, on stem and rhizoids, clavate to subround, with transverse and longitudinal septa, reddish brown.

Dioicous. *Perigonia* terminal, quickly lateral by subperigonial innovation; leaves ovate or shortly ovate-acuminate. *Perichaetia* terminal, leaves scarcely differentiated. *Seta* 7–14 mm long, yellowish or brownish. *Capsule* cylindrical or narrowly pyriform, yellowish or brown, plicate, mouth sulcate dry, reddish brown, urn 1.5–1.8 mm long, neck 0.5 mm long; exothecial cells irregularly quadrate to rectangular, smaller at mouth, longitudinal walls incrassate above; annulus apparently absent. *Peristome* absent. *Operculum* 1 mm long, oblique. *Calyptra* 2.4 mm long, hairy, hairs ascending, uniseriate, smooth, cells smooth. *Spores* 16–20 µm, papillose. Fig. 134: 12–23.

Zygodon erosus is known from India, and central, eastern and southern Africa. In southern Africa the species occurs on bark or infrequently on forest litter in montane forests of the eastern Transvaal region and KwaZulu-Natal. Map 190.

Vouchers: *Esterhuysen 20216; Magill 5508, 5527, 5616; Sim 10045, 10070; Stirton 8991; Van Rooy 1629.*

Plants of this species are easily identified by the numerous clavate to subround gemmae, with transverse and longitudinal septa, on the stems and rhizoids. The narrower leaves with acute to acuminate, apiculate apices and the



MAP 190.—**Zygodon erosus**

gemmae characters separate *Z. erosus* from the closely related *Z. trichomitrius*.

Insufficiently known species

Zygodon cernuus C. Müll. in Hedwigia 38: 114 (1899); Broth. in Natürl. PflFam., edn 2, 11: 14 (1925); Malta, Die Gattung *Zygodon* 56 (1926). Type: Cape, Somerset East, Mt Boschberg, Jan. 1878, *MacOwan s.n.* Sim (1926) did not see the type and it could not be located for this treatment.

Zygodon perreflexus C. Müll. in Hedwigia 38: 115 (1899); Broth. in Natürl. PflFam., edn 2, 11: 14 (1925); Malta, Die Gattung *Zygodon* 134 (1926). Type: Cape, Cape Town, Claremont, Oct. 1876, *Rehmann 297*. The type could not be located. The specimen *Rehmann 148* (PC!, BM!) collected at Rondebosch and originally named as *Z. perreflexus,* is *Z. leptobolax.*

2. **AMPHIDIUM**

Amphidium *Schimp.* nom. cons., Coroll. bryol. eur. 39 (1856); Broth. in Natürl. PflFam., edn 2, 10: 192 (1924); Nyholm, Moss Fl. Fenn. 309 (1954); Sainsb., N. Zeal. Mosses 197 (1955); Gangulee, Moss. E. India 5: 1150 (1976); Crum & Anderson, Moss. E.N. Amer. 2: 683 (1981); Van Rooy in Lindbergia 17: 59 (1992). Type species: *A. lapponicum* (Hedw.) Schimp.

Plants small to medium-sized, densely caespitose; saxicolous to terricolous. *Stems* erect, papillose. *Leaves* ± crowded, erect and crisped when dry, erect-spreading and flexuose when wet, keeled, unistratose; narrowly oblong-lanceolate or linear-lanceolate; apex acute to acuminate; base

scarcely differentiated, sheathing; margins entire or irregularly serrate. *Costa* ending below apex; in section with median guide cells. *Upper laminal cells* rounded, incrassate, papillose on dorsal and ventral surface, occasionally striolate; basal cells rectangular, smooth to striolate.

Autoicous. *Perigonia* terminal on short, subperichaetial branches; perichaetia terminal, leaves weakly or strongly differentiated. *Seta* short. *Capsule* erect to inclined, immersed or short-exserted, short-pyriform or urceolate, 8-ribbed; stomata phaneropore; annulus and peristome absent. *Operculum* conic-apiculate or conic-rostellate. *Calyptra* cucullate, naked, cells generally papillose. *Spores* subround to subtriangular, papillose, brownish.

Amphidium contains 12 species and is found on every continent except Antarctica. Five species are known from Africa.

The genus is recognized by its narrow leaves; median guide cells of the costa; rounded and papillose to striolate-papillose upper laminal cells; immersed to shortly exserted, 8-ribbed, gymnostomous capsule; and cucullate, naked calyptra.

The similarities between *Amphidium* and *Orthotrichum* in the development of the young capsules and the papillose calyptrae (Lewinsky 1976), and other morphological characters indicate a position in the Orthotrichaceae rather than in Dicranaceae or Rhabdoweisiaceae.

Leaf margin irregularly serrate above; perichaetial leaves not or scarcely differentiated, linear-lanceolate, 2.5–3.8 mm long . . . . . 1. *A. tortuosum*
Leaf margin entire; perichaetial leaves differentiated, abruptly apiculate or acuminate above an oval or oblong base, 1.2–2.0 mm long . . . . . 2. *A. lapponicum*

1. **Amphidium tortuosum** *(Hornsch.) Cufodontis* in Oesterr. Bot. Z. 98: 221 (1951); Van Rooy in Lindbergia 17: 59 (1992). Type: Cape, 'Bei dem Wasserfalle auf der östlichen Seite des Teufelsberges, 3te Höhe', *Ecklon* (not located).

Syrrhopodon tortuosus Hornsch. in Linnaea 15: 117 (1841).

Zygodon cyathicarpus Mont. in Ann. Sci. Nat. Bot. 3,4: 106 (1845). *Amphoridium cyathicarpum* (Mont.) Jaeg., Ber. Thätigk. St. Gallischen Naturwiss. Ges. 1872–1873: 108 (1874). *Amphidium cyathicarpum* (Mont.) Broth. in Natürl. PflFam. 1,3: 460 (1902); Sim, Bryo. S. Afr. 267 (1926); *vide* Robinson in Smithsonian Contr. Bot. 27: 20 (1975). Type: Chile.

Plants small, yellow-green to green above, yellow-brown to brown below; saxicolous to terricolous. *Stems* up to 28 mm tall, branching by subperichaetial innovations, scarcely tomentose below; rhizoids red or reddish brown, smooth to papillose; in section subround to subtriangular, inner cortex 4–8 cells across, thin-walled, outer cortical cells smaller, in 1 or 2 rows, rarely absent on one side, incrassate, minutely papillose. *Leaves* crowded, ± equal in size, erect and crisped when dry, erect-spreading and flexuose when wet; linear-lanceolate to linear, 2.0–4.8 mm long; apex acute to acuminate, with a single apical tooth; margins plane, frequently recurved on one side below, irregularly serrate, frequently denticulate at shoulders, rarely decurrent. *Costa* ending below apex; ventral and dorsal superficial cells narrowly rectangular; in section crescent-shaped to subround, bulging dorsally, ventrally flat, laminal insertion ventral, guide cells in one layer medially, ventral substereid or stereids in one layer, papillose, dorsal stereids in 1 or 2 rows, surface rough. *Upper laminal cells* rounded-quadrate or oval, incrassate, bulging ventrally, papillose, striolate, 6–14 µm, papillae low, blunt, scattered over dorsal and ventral surface; basal cells rectangular, thin-walled, smooth to striolate.

Autoicous. *Perigonia* terminal on short, subperichaetial branches; inner leaves ovate to ovate-apiculate to ovate-acuminate, margins irregularly crenulate. *Perichaetia* terminal, frequently overgrown by subperichaetial innovations; leaves scarcely differentiated, linear-lanceolate, 2.5–3.8 mm long, sheathing below,

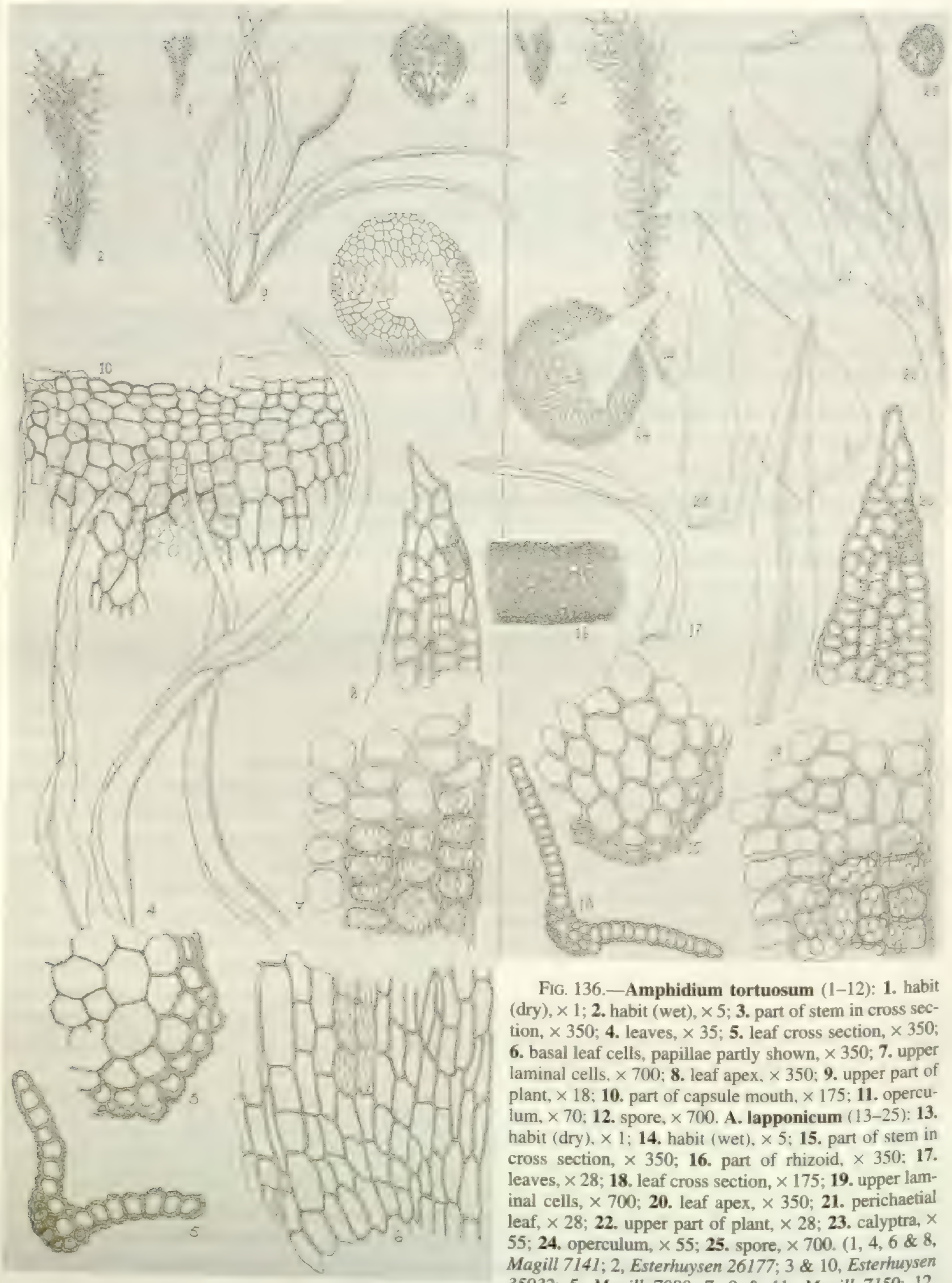
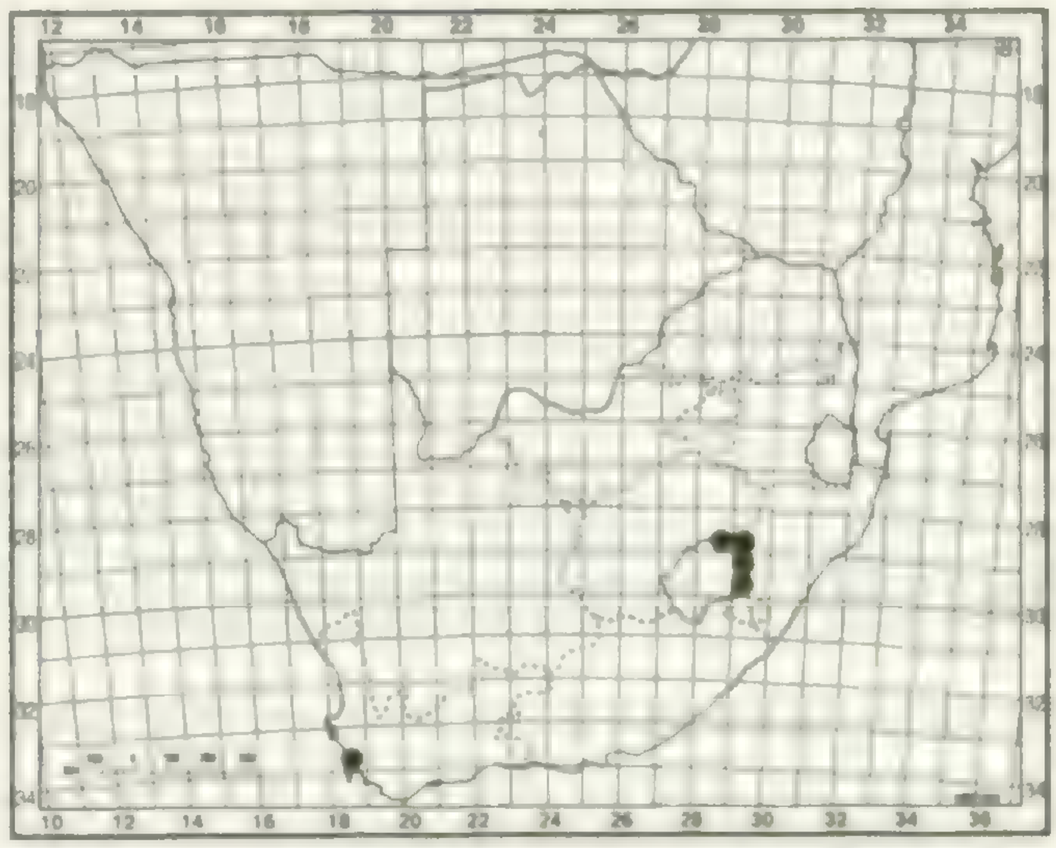


FIG. 136.—**Amphidium tortuosum** (1–12): **1.** habit (dry), × 1; **2.** habit (wet), × 5; **3.** part of stem in cross section, × 350; **4.** leaves, × 35; **5.** leaf cross section, × 350; **6.** basal leaf cells, papillae partly shown, × 350; **7.** upper laminal cells, × 700; **8.** leaf apex, × 350; **9.** upper part of plant, × 18; **10.** part of capsule mouth, × 175; **11.** operculum, × 70; **12.** spore, × 700. **A. lapponicum** (13–25): **13.** habit (dry), × 1; **14.** habit (wet), × 5; **15.** part of stem in cross section, × 350; **16.** part of rhizoid, × 350; **17.** leaves, × 28; **18.** leaf cross section, × 175; **19.** upper laminal cells, × 700; **20.** leaf apex, × 350; **21.** perichaetial leaf, × 28; **22.** upper part of plant, × 28; **23.** calyptra, × 55; **24.** operculum, × 55; **25.** spore, × 700. (1, 4, 6 & 8, *Magill 7141*; 2, *Esterhuysen 26177*; 3 & 10, *Esterhuysen 35932*; 5, *Magill 7088*; 7, 9 & 11, *Magill 7159*; 12, *Magill 7150*; 13, 14, 16 & 20, *Van Rooy 1304*; 15, 17, 21, 23 & 24, *Van Rooy 1316*; 18, 19 & 22, *Van Rooy 1308*; 25, *Van Rooy 3081*.)

base oblong or oval. *Seta* 0.9–1.5 mm long, frequently curved, yellowish. *Capsule* erect to inclined, immersed, urceolate, brownish, urn 0.3–0.5 mm long, neck 0.2–0.3 mm long; exothecial cells irregularly rhomboidal to rectangular, ± thin-walled, in 2 or 3 transverse rows at mouth, smaller at mouth; stomata present on neck. *Operculum* conic-apiculate, oblique. *Calyptra* 0.5–0.6 mm long, cells smooth to papillose. *Spores* 12–22 µm. Fig. 136: 1–12.

Primarily a southern hemisphere species, *Amphidium tortuosum* is known from Mexico, South America, Juan Fernández islands, South Georgia, Hawaii, Australasia, Indonesia and sub-Saharan Africa. In southern Africa the species is rarely collected from rock crevices on the mountains of KwaZulu-Natal and Lesotho and on Table Mountain in the south-western Cape region. Map 191.



MAP 191.—**Amphidium tortuosum**

Vouchers: *Esterhuysen 26177, 35932; Magill 7141, 7150, 7159; Van Zanten 7609902.*

The plants are recognized by their crisped, linear-lanceolate to linear leaves with irregularly serrate margins and striolate-papillose cells, scarcely differentiated perichaetial leaves and immersed capsules.

2. **Amphidium lapponicum** *(Hedw.) Schimp.*, Coroll. bryol. eur. 39 (1856); Broth. in Natürl. PflFam., edn 2, 10: 193 (1924); Nyholm, Moss Fl. Fenn. 310 (1954); Crum & Anderson, Moss. E.N. Amer. 2: 685 (1981); Van Rooy in Lindbergia 17: 62 (1992). Type: *Hedwigia lapponica* Hedw. St. Cr. v. 3. p. t., nomine Gymnost., Exempl. a Cl. Swartz. (G, holo.!).

Anictangium lapponicum Hedw., Sp. musc. frond. 40 (1801). *Zygodon lapponicus* (Hedw.) B.S.G., Bryol. eur. 3: 38 (1838). *Amphoridium lapponicum* (Hedw.) Schimp. in Syn. musc. eur. 1: 247 (1860).

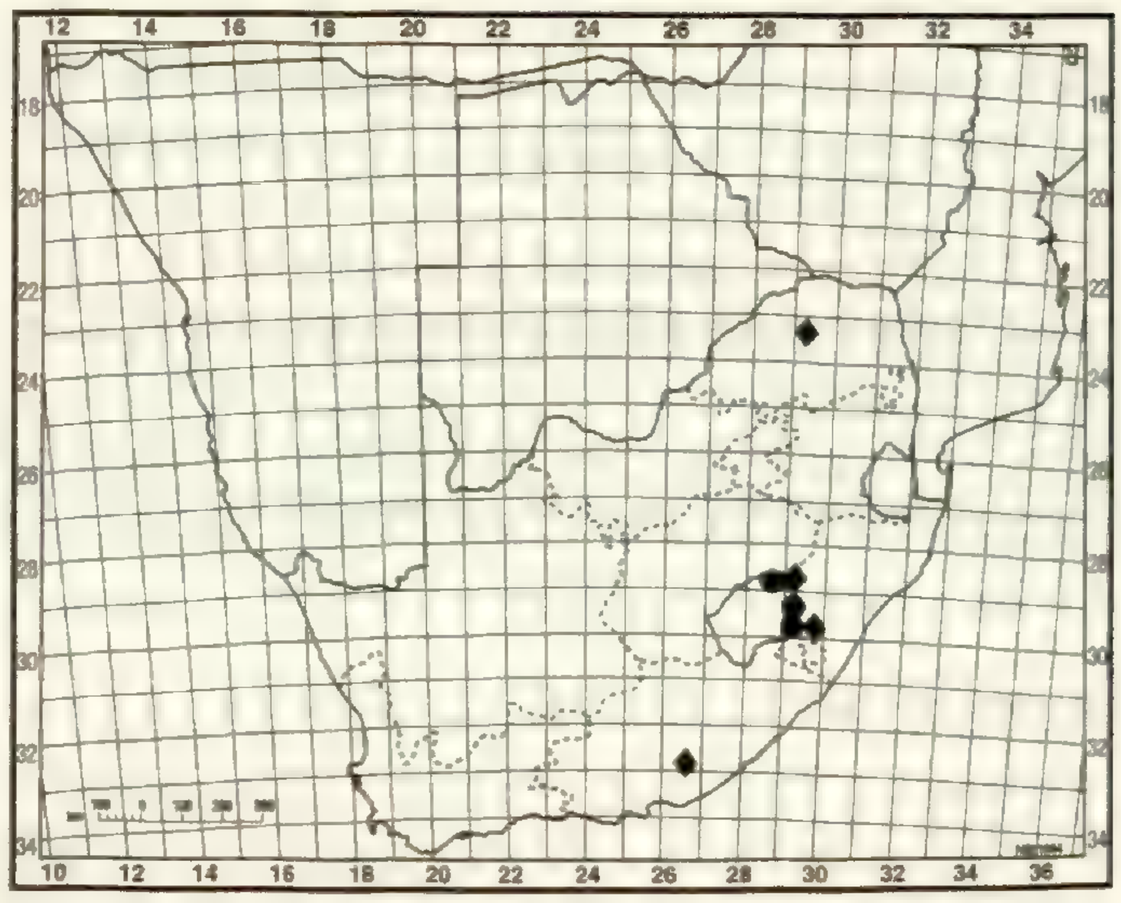
Plants small to medium-sized, yellowish green to green above, brown below; saxicolous. *Stems* up to 38 mm tall, branching by subperichaetial innovations, scarcely tomentose below; rhizoids red-brown, smooth to papillose; in section subround to subtriangular. inner cortex 5–10 cells across, thin-walled or ± incrassate, outer cortical cells smaller, in 1 or 2 rows, incrassate, papillose. *Leaves* ± crowded, ± equal in size, erect and crisped when dry, erect-spreading and flexuose when wet; narrowly oblong-lanceolate to linear-lanceolate, 2.0–3.3 mm long; apex acute to acuminate, frequently with a single apical tooth; margins plane above, recurved below, entire, rarely decurrent. *Costa* ending below apex; ventral and dorsal superficial cells narrowly rectangular; in section subround or crescent-shaped, bulging dorsally, ventrally flat, laminal insertion ventral, guide cells in one layer medially, ventral substereids or stereids in one layer, papillose, dorsal substereids or stereids in 1 or 2 rows, papillose. *Upper laminal cells* irregularly rounded, incrassate, ± flat, papillose, weakly striolate, 8.7–15.0 µm, papillae ± low, blunt, scattered over dorsal and ventral surface; basal cells rectangular, thin-walled to incrassate, smooth to striolate.

Autoicous. *Perigonia* terminal on short, subperichaetial branches; inner leaves ovate-apiculate or ovate-acuminate. *Perichaetia* terminal, frequently overgrown by subperichaetial innovations; leaves differentiated, sheathing, oval or oblong, 1.2–2.0 mm long, apex abruptly apiculate or acuminate, costa ending below apex, upper laminal cells irregularly rectangular or rhomboidal to vermiculate, incrassate, striolate. *Seta* short, 0.4–0.6 mm long, yellowish to brown.

Capsule erect, immersed to shortly exserted, shortly pyriform or urceolate, brownish, urn 0.5–0.7 mm long, neck 0.3–0.6 mm long; exothecial cells irregularly rhomboidal to rectangular, incrassate, in 2–5 transverse rows at mouth, smaller at mouth; stomata present at base of urn and on neck. *Operculum* conic-rostellate, beak turned to one side. *Calyptra* 1 mm long, cells papillose. *Spores* 11–14 µm. Fig. 136: 13–25.

Amphidium lapponicum is widely distributed in temperate to arctic regions of the northern hemisphere, disjunct in South Africa and probably New Zealand, and also known from Macaronesia and northern Africa. In southern Africa the species is known from wet basalt rock crevices in the Drakensberg Mountains of KwaZulu-Natal and the Maluti Mountains in Lesotho. Map 192.

Vouchers: *Esterhuysen 25177a; Van Rooy 1304, 1308, 1316, 3081, 3104.*



MAP 192.— ● **Amphidium lapponicum**
♦ **Orthotrichum firmum**

The species is distinguished from *Amphidium tortuosum* by its broader leaves with entire margins and larger papillae on the cells, differentiated perichaetial leaves, and immersed to short-exserted capsules.

Subfamily ORTHOTRICHOIDEAE

Plants small to medium-sized; saxicolous, terricolous or corticolous. *Primary stems* erect, simple or sparsely branched. *Leaves* appressed, erect or crisped when dry; ovate-lanceolate, oblong to oblong-lanceolate or linear-lanceolate above an oval or ovate base; base rarely strongly differentiated. *Upper laminal cells* rounded-hexagonal or irregularly rounded, incrassate, smooth or papillose; basal cells mostly rectangular. *Gemmae* absent or present, on leaf lamina or rarely on rhizoids.

Perichaetia terminal on primary stems and branches. Dwarf male plants absent. *Capsule* immersed, emergent or short-exserted, frequently ribbed. *Stomata* phaneropore or cryptopore. *Peristome* double. *Calyptra* mitrate, hairy. Isosporous.

3. **ORTHOTRICHUM**

Orthotrichum *Hedw.*, Sp. musc. frond. 162 (1801); Broth. in Natürl. PflFam., edn 2, 11: 17 (1925); Sim, Bryo. S. Afr. 273 (1926); Nyholm, Moss Fl. Fenn. 321 (1954); Vitt in Nova Hedwigia 21: 683–711 (1971); Smith, Moss Fl. Brit. Irel. 473 (1978); Lewinsky in Lindbergia 4: 68 (1978); Crum & Anderson, Moss. E.N. Amer. 2: 687 (1981). Lectotype species: *O. anomalum* Hedw., *vide* Grout, Moss Fl. N. Amer. 2: 106 (1935).

Plants small to medium-sized, loosely caespitose to caespitose; corticolous or saxicolous. *Stems* erect, simple or sparsely branched by subperichaetial innovations, scarcely tomentose below; rhizoids smooth, reddish brown. *Leaves* erect to appressed when dry, occasionally flexuose, erect-spreading to spreading or recurved below when wet; unistratose or rarely bistratose; generally

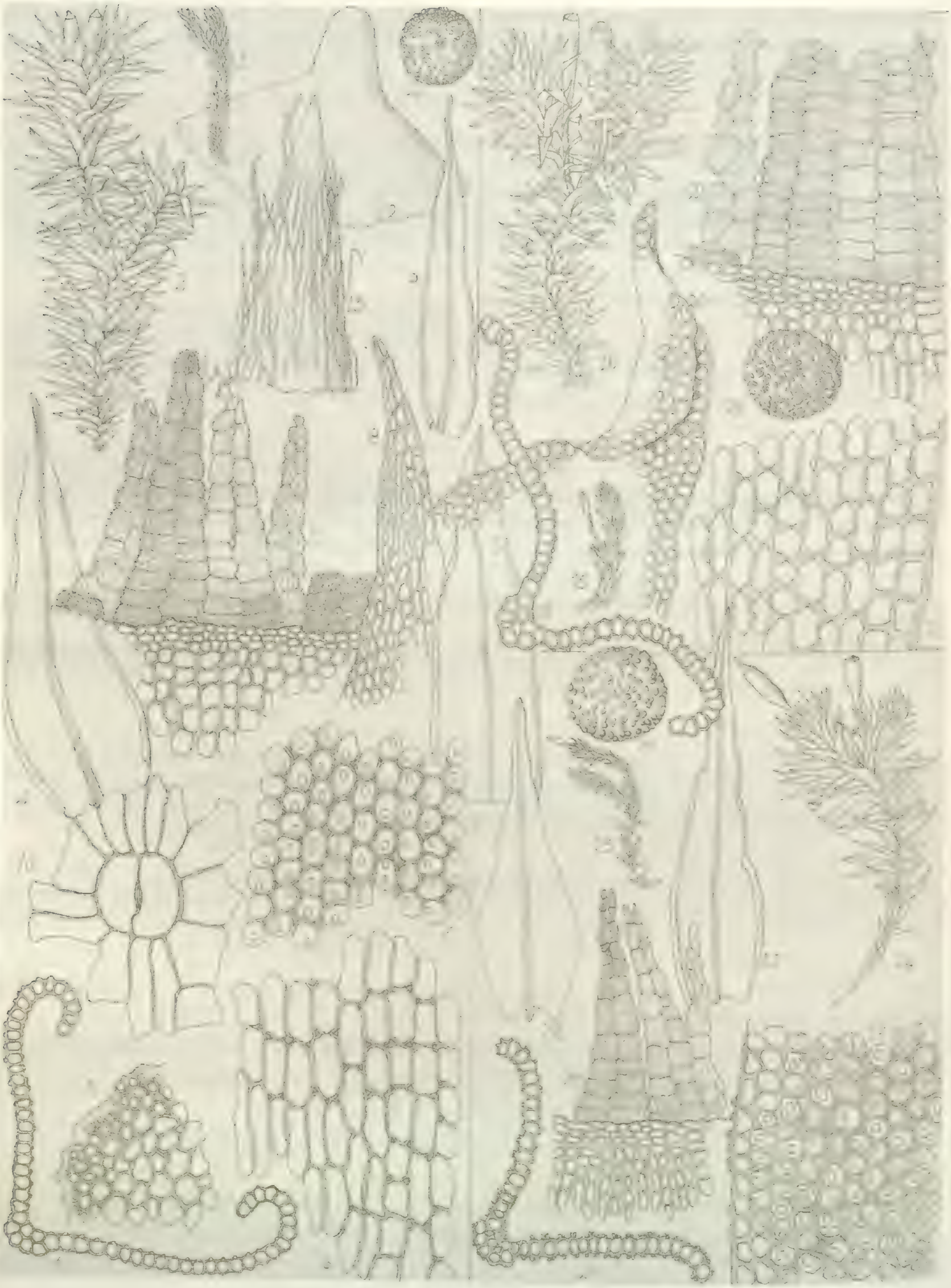
ovate-lanceolate; margins incurved or recurved to revolute. *Costa* with cells scarcely differentiated in section. *Upper laminal cells* mostly rounded-hexagonal, frequently incrassate, flat to bulging, smooth or papillose; basal cells rectangular to quadrate, smooth or papillose. *Gemmae* present or absent, filiform, uniseriate, on leaf lamina or rarely terminal on rhizoid.

Autoicous. *Perigonia* gemmate. *Perichaetia* terminal; leaves scarcely differentiated, inner leaves smaller. *Seta* brownish. *Capsule* immersed, emergent or exserted, ovate-cylindrical to cylindrical, smooth or frequently 8-ribbed, brownish, neck short; stomata phaneropore or cryptopore. *Peristome* double, exostome teeth 16 or in 8 pairs; endostome processes absent, 8 or 16, alternating with teeth, stout or slender, 1 or 2 cells wide, basal membrane low or absent. *Operculum* conic-rostellate or conic-apiculate. *Calyptra* mitrate, plicate, frequently lobed below, hairy. *Spores* subround to round, brownish, papillose or granulate.

The genus contains ± 200 species and is mainly temperate in distribution. South America is the major centre of described species, followed by North America and Europe. Of the eight species present in southern Africa, four are endemic, two are also known from eastern Africa and two are widespread.

Orthotrichum is characterized by erect stems with erect to appressed or occasionally flexuose leaves and mitrate, hairy and usually plicate calyptrae. The southern African species with cryptopore stomata belong to section *Diaphanum* Vent. (subgenus *Orthotrichum*), *O. rupestre* belongs to section *Rupestria* Schimp. (subgenus *Phaneroporum* Delogne) and the remaining phaneropore species belong to section *Leiocarpa* Mol. (subgenus *Phaneroporum*). The adaptation to xeric habitats on rock and tree trunks is the major evolutionary trend in the genus (Vitt 1971).

1 Leaf margins incurved . . . . . 3. *O. incurvomarginatum*
1 Leaf margins recurved to revolute:
 2 Stomata phaneropore:
  3 Capsule exserted:
   4 Exostome teeth 16; endostome segments 16 . . . . . 1. *O. firmum*
   4 Exostome teeth in 8 pairs; endostome segments 8 . . . . . 2. *O. oreophilum*
  3 Capsule immersed to emergent:
   5 Leaf apex acute to acuminate; exostome teeth 16; endostome segments absent or 16, narrow . . . . . 5. *O. rupestre*
   5 Leaf apex acuminate to mostly aristate; exostome teeth in 8 pairs; endostome segments 8, broad . . . . . 4. *O. armatum*
 2 Stomata cryptopore:
  6 Leaf apex aristate, cells elongate; costa merging with apical cells . . . . . 8. *O. diaphanum*
  6 Leaf apex rounded-obtuse, acute, acuminate or apiculate, cells not or scarcely differentiated, rounded; costa ending below apex or subpercurrent:
   7 Leaves mostly oblong-lanceolate or elliptic; apex apiculate; margins recurved at midleaf, frequently plane above and below . . . . . 7. *O. transvaalense*
   7 Leaves narrowly ovate-lanceolate or lanceolate; apex variable, rounded-obtuse, acute or acuminate, frequently channelled; margins broadly recurved to revolute . . . . . 6. *O. subexsertum*



1. **Orthotrichum firmum** *Vent.* in Nuovo Giorn. Bot. Ital. 4: 15 (1872); Broth. in Natürl. PflFam., edn 2, 11: 20 (1925); Lewinsky & Van Rooy in J. Bryol. 16: 76 (1990). Type: Bogos Abyssiniae circa Keren, *Beccari s.n. fide* Lewinsky in Bot. Tidsskr. 72: 65 (1978).

Plants small to medium-sized, caespitose, yellowish green or olivaceous above, green-brown below; corticolous. *Stems* 15–25 mm tall, scarcely tomentose below; in section subround, central strand absent, inner cortex 7–13 cells across, thin-walled to incrassate, outer cortical cells smaller, in 2–4 rows, incrassate to stereids, epidermis not differentiated. *Leaves* ± crowded, erect when dry, spreading when wet; ovate-lanceolate to lanceolate, (2.2–)2.8–3.5 (–5.0) mm long; ventral surface keeled; apex acute to acuminate, frequently channelled, 0.1–0.2(–0.3) mm long; margins recurved, entire, flexuose; unistratose. *Costa* ending below apex or extending into channelled apex; superficial cells rounded above, linear below, flat to bulging, smooth; in section crescent-shaped to subround, bulging dorsally, cells scarcely differentiated, incrassate. *Upper laminal cells* rounded-hexagonal to oval, incrassate, slightly bulging, 11–20 µm long, papillae low, blunt, 1–3 over lumen, mostly simple; basal cells smooth or walls papillose, rectangular, quadrate towards margin, thin-walled to incrassate.

Gonioautoicous. *Perigonial* leaves ovate. *Perichaetia* terminal; leaves scarcely differentiated, inner leaves smaller. *Seta* 2.4–3.8 mm long, occasionally polysetaceous, twisted anticlockwise above. *Capsule* exserted, oblong-cylindrical, 1.5–2.5 mm long, 8-ribbed above, neck weakly differentiated; exothecial cells irregularly rectangular, longitudinal walls incrassate, shorter at mouth; stomata at base of urn and on neck, phaneropore. *Peristome* double; exostome teeth 16, recurved when dry, oblong, blunt, 300–350 µm long, yellowish brown, densely papillose; basal membrane absent, processes 16, alternating with teeth, 200–310 µm long, 2 cells wide, cell divisions prominent below, papillose. *Operculum* 0.5 mm long, conic-rostellate, yellowish with reddish brown rim. *Calyptra* 3.0–3.5 mm long; hairs ascending, papillose. *Spores* 20–35 µm, papillose. Fig. 137: 15–22.

Known from eastern and central Africa, India, and recently reported from southern Africa. The species is rarely collected in montane forests and wooded areas of the northern Transvaal area, KwaZulu-Natal and the eastern Cape region. Map 192.

Vouchers: *Magill 3710, 5686a, 5691.*

The recurved leaf margins, channelled apex, long-exserted capsule and 16 exo- and endostome teeth separate *O. firmum* from other phaneropore species in the *Flora* area.

2. **Orthotrichum oreophilum** *Lewinsky & Van Rooy* in J. Bryol. 16: 74 (1990). Type: Lesotho, Kotisephola Pass, *Van Rooy 3423* (PRE, holo.!).

Plants small to medium-sized, loosely caespitose to caespitose, olivaceous to dark green above, dark green to brownish below; saxicolous. *Stems* 10–28 mm tall; in section subpen-

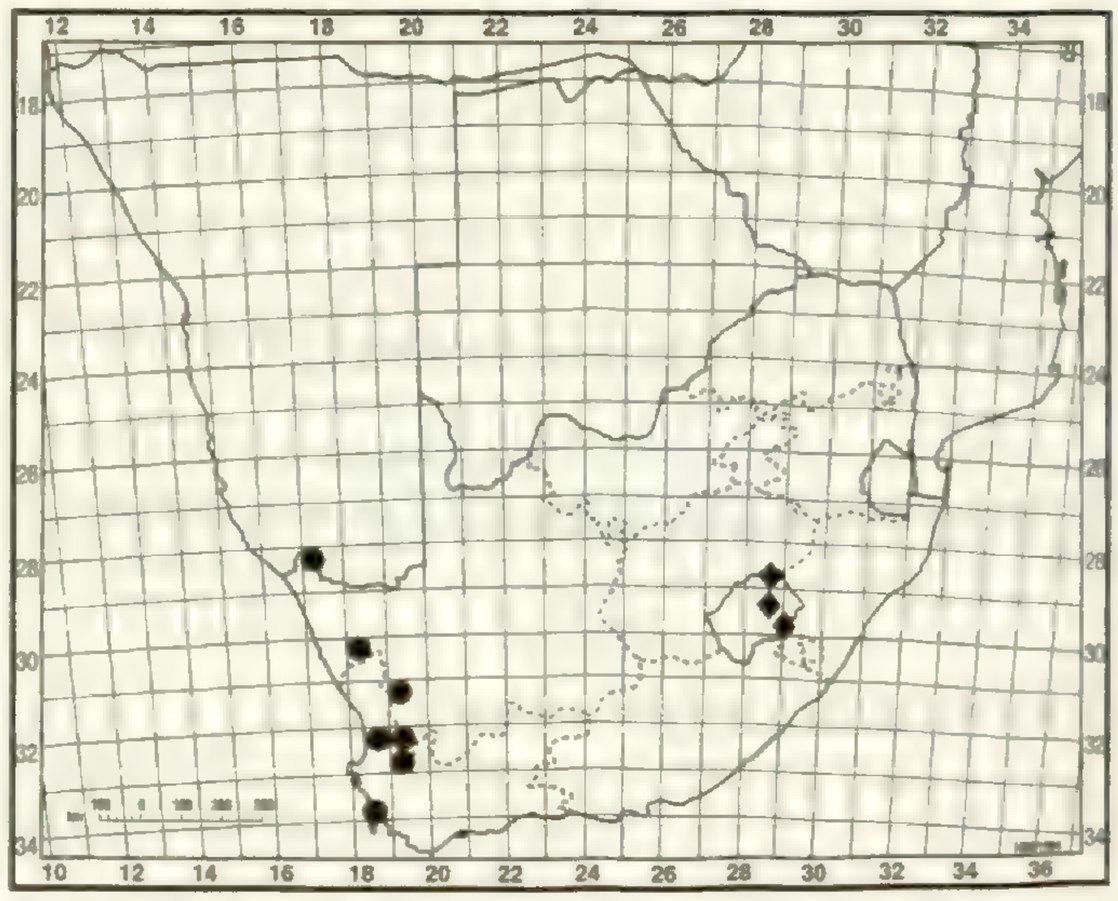
FIG. 137.—**Orthotrichum incurvomarginatum** (1–14): **1.** habit (dry), × 1.4; **2.** habit (wet), × 5; **3.** part of stem in cross section, × 175; **4.** leaf, × 18; **5.** leaf in cross section, × 175; **6.** basal leaf cells, × 350; **7.** upper laminal cells, × 350; **8.** cells at leaf apex, × 175; **9.** perichaetial leaf, × 18; **10.** part of capsule wall with stoma, × 350; **11.** part of capsule mouth with peristome (papillae partly shown), × 175; **12.** operculum, × 88; **13.** calyptra, × 18; **14.** spore, × 700. **O. firmum** (15–22): **15.** habit (dry), × 1.4; **16.** habit (wet), × 5; **17.** leaf, × 18; **18.** leaf in cross section, × 175; **19.** basal leaf cells (right side), × 350; **20.** leaf apex, × 175; **21.** part of capsule mouth with peristome (papillae partly shown), × 175; **22.** spore, × 700. **O. oreophilum** (23–30): **23.** habit (dry), × 1; **24.** habit (wet), × 5; **25.** leaf, × 25; **26.** leaf in cross section, × 175; **27.** upper laminal cells (left side), × 350; **28.** perichaetial leaf, × 50; **29.** part of capsule mouth with peristome (papillae partly shown), × 175; **30.** spore, × 700. (1, 2 & 4, *Magill & Schelpe 3975*; 3 & 9, *Magill & Schelpe 4022*; 5–7, *Magill & Schelpe 3943*; 8, 10 & 13, *Schelpe 4968*; 11, *Magill & Schelpe 4012*; 12, *Barnard 49647*; 14, *Van der Westhuizen PRE-CH13542*; 15, 16, 18, 19 & 22, *Magill 5691*; 17, *Magill 3710*; 20, *Sim PRE-CH5736*; 21, *Oliver 6775*; 23, 24, 28 & 30, *Van Rooy 3423*; 25, *Van Rooy 3376*; 26, *Van Rooy 3033*; 27, *Van Rooy 3078*; 29, *Van Rooy 3075*.)

tagonal to subround, central strand absent, inner cortex 6–8 cells across, incrassate, outer cortical cells smaller, in 1–3 rows, substereids to stereids, epidermis not differentiated. *Leaves* ± crowded above, erect to erect-spreading, frequently flexuose when dry, spreading when wet; unistratose; ovate-lanceolate to narrowly lanceolate, (1.4–)2.0–3.0(–3.7) mm long; ventral surface keeled; apex acuminate; margins irregularly recurved, entire, unistratose. *Costa* ending below apex; superficial cells rounded above to linear below, bulging dorsally, papillose; in section crescent-shaped to subround, bulging dorsally, cells scarcely differentiated, incrassate to substereids. *Upper laminal cells* irregularly rounded-hexagonal to oval, incrassate, flat to slightly bulging, 10–20 µm, papillae bifid; basal cells yellowish to orange or reddish brown below, rectangular to quadrate at margin, incrassate, walls occasionally papillose, frequently pitted, cells occasionally inflated at corners.

Gonioautoicous. *Perigonial leaves* ovate. *Perichaetia* terminal; inner leaves narrowly subtriangular, as long as stem leaves or inner leaves smaller. *Seta* 1.2–1.8 mm long, straight or slightly twisted anticlockwise above. *Capsule* shortly exserted, oblong-cylindrical, 1.6–2.0 mm long, smooth, neck weakly differentiated; exothecial cells irregularly rectangular to quadrate above, longitudinal walls strongly incrassate; stomata phaneropore, on urn. *Peristome* double, exostome teeth in 8 pairs, triangular, cleft down middle, perforated above, 140–260 µm long, pale yellow, papillose, frequently with vermiculate lines; basal membrane absent, processes 8, alternating with teeth pairs, narrowly oblong or linear, frequently 2 cells wide, 125–210 µm long, median lines conspicuous, ± papillose. *Operculum* conic-rostellate, 0.3–0.5 mm long, yellowish with reddish brown rim. *Calyptra* 2.0–2.3 mm long, hairs multiseriate, papillose. *Spores* 15–25 µm, granulate. Fig. 137: 23–30.

Endemic to the mountains of Lesotho, *O. oreophilum* has been collected only above 3000 m. Map 193.

Vouchers: *Magill 4569; Van Rooy 3015, 3033, 3376.*



MAP 193.— ♦ **Orthotrichum oreophilum**
● **Orthotrichum incurvomarginatum**

Growing on rock like *O. rupestre*, this phaneropore species can be recognized by the erect to erect-spreading, flexuose leaves when dry, generally acuminate leaf apex, exserted capsule, 8 exostome teeth pairs, 8 endostome processes and strongly incrassate exothecial cells.

3. **Orthotrichum incurvomarginatum** *Lewinsky & Van Rooy* in J. Bryol. 16: 67 (1990). Type: Cape, upper slopes of Mount Synnott, 7 km N of Clanwilliam, *Magill & Schelpe 4012* (PRE, holo.!).

Plants small to medium-sized, caespitose, yellowish green or olivaceous above, yellowish brown or brown-green below; corticolous. *Stems* 8–26 mm tall, scarcely tomentose below; in section subround to subpentagonal, central strand absent, inner cortex 11–14 cells across, thin-walled to incrassate, outer cortical cells smaller, in 1–4 rows, incrassate to stereids, epidermis not differentiated, outer surface rough. *Leaves* ± crowded, erect when dry, spreading when wet; ovate-lanceolate to lanceolate, 2.4–3.7(–4.3) mm long; ventral surface keeled; apex narrowly acuminate to subulate, 0.1–0.4 (–0.7) mm long, cells rounded to elongate; margins incurved, entire; unistratose. *Costa* weak above, extending into acumen; ventral and dorsal superficial cells rounded above, linear

below, flat to bulging, smooth to weakly papillose; in section crescent-shaped to subround, bulging dorsally, cells scarcely differentiated, incrassate. *Upper laminal cells* rounded-hexagonal to oval, incrassate, slightly bulging, 10.0–18.7(–33.0) µm long, papillae low, blunt, 1–3 over lumen, simple or forked; basal cells smooth or papillose, rectangular, quadrate towards margin, generally thin-walled.

Gonioautoicous. *Perigonial leaves* ovate. *Perichaetia* terminal; leaves narrowly oblong or lanceolate, 2.0–3.6 mm long, apex acuminate to subulate, 0.2–0.6(–1.0) mm long, costa extending into acumen. *Seta* short, (0.3–)0.5–0.8(–1.3) mm long. *Capsule* immersed to emergent, oblong-cylindrical, 1.9–2.3(–3.0) mm long, 8-ribbed, neck differentiated; exothecial cells rectangular, longitudinal walls incrassate, shorter at mouth; stomata at base of urn and on neck, phaneropore. *Peristome* double; exostome teeth in 8 pairs, triangular, 160–275 µm long, densely papillose; basal membrane absent, processes 8, alternating with teeth pairs, 175–240 µm long, 2 cells wide, coarsely papillose, cell divisions prominent below. *Operculum* 0.3 mm long, conic-apiculate, yellowish with red or red-brown rim. *Calyptra* 2.5–3.0 mm long; hairs ascending, multi- to uniseriate, crenulate to denticulate, smooth to papillose. *Spores* 16–25 µm, papillose. Fig. 137: 1–14.

Endemic to southern Africa, *O. incurvomarginatum* is found on indigenous and exotic trees and shrubs in the winter rainfall regions of the southwestern and northwestern Cape. Map 193.

Vouchers: *Barnard PRE-CH3114; Magill & Schelpe 3943, 4025; Schelpe 4968.*

The incurved leaf margins distinguish *O. incurvomarginatum* from other species of the genus in the *Flora* area.

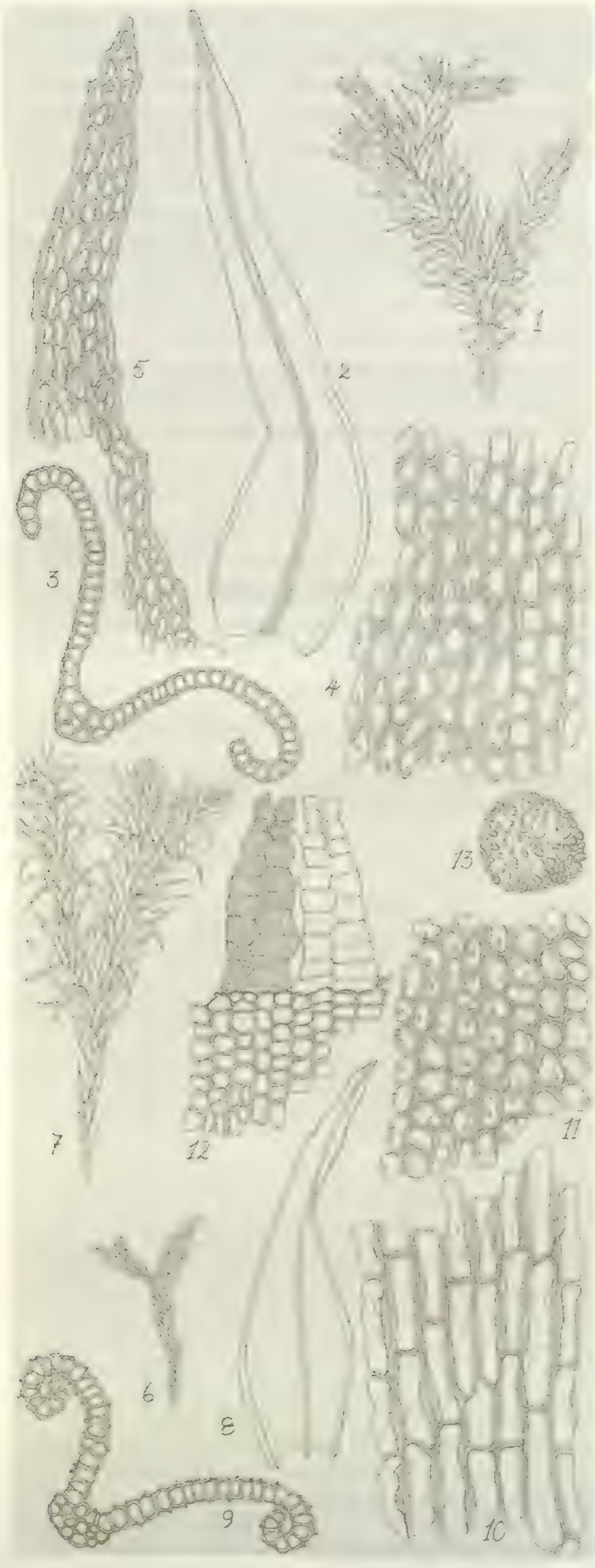
4. **Orthotrichum armatum** *Lewinsky & Van Rooy* in J. Bryol. 16: 69 (1990). Type: Cape, Hogsback, *Oliver 6775* (C, holo.!).

Plants medium-sized, mixed with other bryophytes, olivaceous or yellowish green above, greenish brown to brown below; corticolous. *Stems* 10–15 mm tall; in section subpentagonal to subround, central strand absent, inner cortex 12–14 cells across, incrassate, outer cortical cells smaller, in 2–4 rows, substereids to stereids, epidermis not differentiated, outer surface rough. *Leaves* ± crowded, erect when dry, spreading when wet; unistratose; ovate-lanceolate, 2.5–4.0 mm long; ventral surface keeled; apex narrowly acuminate to aristate, 0.3–0.6 mm long; margins recurved for lower ± three-quarters, plane above, entire to crenulate, unistratose. *Costa* extending into arista; superficial cells rounded to oval above, linear below, ± flat, smooth; in section crescent-shaped to subround, bulging dorsally, cells scarcely differentiated, incrassate. *Upper laminal cells* shortly rounded-rhomboidal, oval or irregular in shape, flat to weakly bulging, (10.0–)15.0–27.5(–35.0) µm long, 7.5–13.8 µm wide, smooth to papillose, papillae low, blunt, mostly simple; basal cells yellowish to yellowish brown below, walls papillose, frequently pitted, rhomboidal to rectangular, quadrate at margin, incrassate.

Gonioautoicous. *Perigonial leaves* ovate. *Perichaetia* terminal; leaves ovate-lanceolate or lanceolate, apex aristate to subulate, inner leaves smaller. *Seta* short, 0.8–1.5 mm long. *Capsule* immersed to emergent, ovate-cylindrical, 1.5–2.2 mm long, 8-ribbed in upper half when dry, neck weakly differentiated; exothecial cells irregularly rectangular, thin-walled to incrassate, smaller at mouth, incrassate; stomata phaneropore, on urn. *Peristome* double; exostome teeth in 8 pairs, reflexed when dry, cleft down middle, triangular, 280–330 µm long, yellowish brown, minutely striolate-papillose; basal membrane absent, processes 8, alternating with tooth pairs, broad, stout, oblong-lanceolate or triangular, blunt, 2 cells wide, dividing lines conspicuous, papillose with ridges along walls. *Operculum* conic-apiculate, 0.4 mm long. *Calyptra* 2.2–3.0 mm long, weakly plicate, hairy. *Spores* 25–34 (–53) µm, papillose. Fig. 138: 1–5.

This endemic is known only from Hogsback in the eastern Cape region. Map 194.

Voucher: type only.



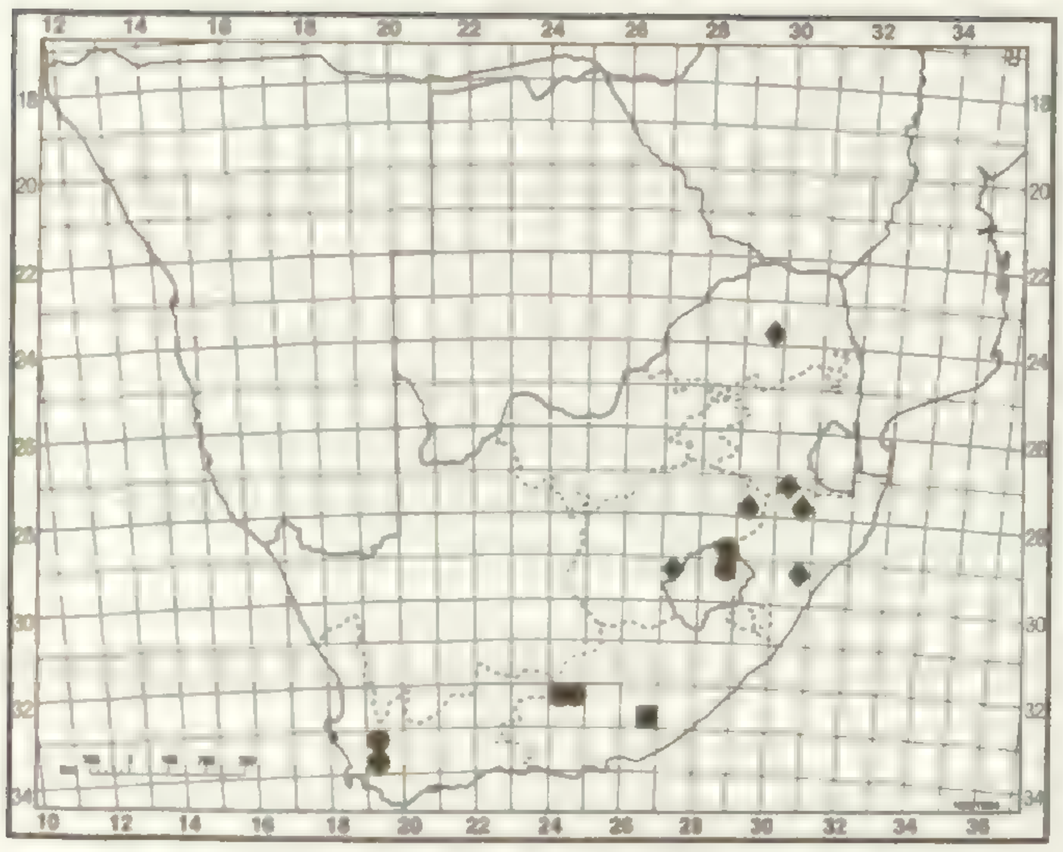
Orthotrichum armatum is most easily separated from other phaneropore species in southern Africa by the narrowly acuminate to aristate leaf apex and recurved margins. The species is also characterized by the crenulate leaf margins, immersed to emergent capsule, 8 pairs of exostome teeth and 8, broad, stout, blunt endostome processes.

5. **Orthotrichum rupestre** *Schleich. ex Schwaegr.*, Sp. musc. frond. suppl. 1,2: 27 (1816); Broth. in Natürl. PflFam., edn 2, 11: 17 (1925); Nyholm, Moss Fl. Fenn. 324 (1954); Lawton, Moss Fl. Pacific Northwest 226 (1971); Crum & Anderson, Moss. E.N. Amer. 2: 696 (1981). Lectotype: Austria, *Schwägrichen s.n.* (G) *fide* Lewinsky in Lindbergia 9: 56 (1983).

Orthotrichum macleanum Shaw in Cape Monthly Mag. 17: 378 (1878). Isotypes: Cape, Graaff-Reinet, *MacLea* sub *Rehmann 514* (BM!; H!; PRE!).

Plants small to medium-sized, caespitose, olivaceous above, dark green or greenish brown below; saxicolous or rarely corticolous. *Stems* 5–40 mm tall, tomentose below; in section subround to subpentagonal, central strand absent, inner cortex 9–20 cells across, thin-walled to incrassate, outer cortical cells smaller, in 2–4 rows, substereids or stereids, epidermis not differentiated, outer surface rough. *Leaves* ± crowded, erect-appressed when dry, erect-spreading to spreading or recurved when wet, unistratose or bistratose; ovate-lanceolate or lanceolate, (1.7–)2.3–3.8(–4.2) mm long; ventral surface keeled; apex acute to acuminate; margins recurved to revolute, entire, unistratose to tristratose. *Costa* subpercurrent; superficial cells rounded to linear, flat to slightly bulging, smooth to papillose; in section crescent-shaped to subround, bulging dorsally, cells scarcely differenti-

FIG. 138.—**Orthotrichum armatum** (1–5): **1.** habit (dry), × 3; **2.** leaf, × 17; **3.** leaf in cross section, × 175; **4.** upper laminal cells, × 350; **5.** cells at leaf apex, × 175. **O. rupestre** (6–13): **6.** habit (dry), × 1; **7.** habit (wet), × 3; **8.** leaf, × 18; **9.** leaf in cross section, × 175; **10.** basal leaf cells, × 350; **11.** upper laminal cells, × 350; **12.** part of capsule mouth with peristome teeth (papillae partly shown), × 175; **13.** spore, × 700. (1–5, *Oliver 6775*; 6 & 7, *Magill 5886*; 8, 11–13, *Rehmann 514*; 9, *Magill 5887a*; 10, *Magill 5913*.)



MAP 194.— ■ **Orthotrichum armatum**
● **Orthotrichum rupestre**
♦ **Orthotrichum transvaalense**

ated, incrassate to substereids. *Upper laminal cells* irregularly rounded-hexagonal, incrassate, flat or slightly bulging, 8.7–15.0 (–22.5) µm long, papillae low, blunt, 1–3 over lumen, simple or bifid; basal cells yellow to orange below, smooth, walls papillose or 1 papilla over lumen, rectangular to quadrate at margin, thin-walled to incrassate, occasionally pitted.

Gonioautoicous. *Perigonial leaves* ovate. *Perichaetia* terminal; leaves ovate-acuminate to oblong-acuminate or lanceolate, (1.8–)3.2–4.5 mm long. *Seta* short, 0.4–1.2 mm long, 1 or 2 per perichaetium. *Capsule* immersed to emergent, 1.4–2.4 mm long, 8-ribbed above; urn ovate-cylindrical to oblong-cylindrical, neck contracted; exothecial cells irregularly rectangular to quadrate, shorter above, incrassate; stomata phaneropore, on urn. *Peristome* single or infrequently double, preperistome occasionally present; exostome teeth 16, narrowly triangular, perforated above, 160–275 µm long, yellowish, coarsely papillose to reticulate; basal membrane absent, processes absent or 16, alternating with exostome teeth, narrow, pale. *Operculum* 0.4–0.6 mm long, conic-rostellate, yellowish brown with reddish brown rim. *Calyptra* 0.8–1.0 mm long, hairy or almost smooth with multicellular outgrowths. *Spores* 15.0–27.5 µm, granulate. Fig. 138: 6–13.

This widespread species has been reported from all continents. In Africa *O. rupestre* is known from northern and eastern Africa and in the *Flora* area it is infrequently collected at high altitudes in Lesotho and the central and south-western Cape regions. The plants grow on rock and rarely on tree trunks in southern Africa. Map 194.

Vouchers: *Barnard PRE-CH6220; Esterhuysen 24359; Magill 5886, 5891, 5913; Van Rooy 2996.*

This variable species is characterized by phaneropore stomata, immersed to emergent capsules with 16 exostome teeth, and leaves with acute to acuminate apices and recurved to revolute margins. African plants generally lack an endostome (Lewinsky 1978) but endostome processes were observed in some specimens from Lesotho (*Van Rooy 2996*). Exostome teeth ornamentation varies from papillose to coarsely papillose to reticulate. One of the Lesotho specimens (*Van Rooy 2996*) differs from other southern African material in the bistratose leaves and the almost naked calyptra with multicellular, leaf-like outgrowths.

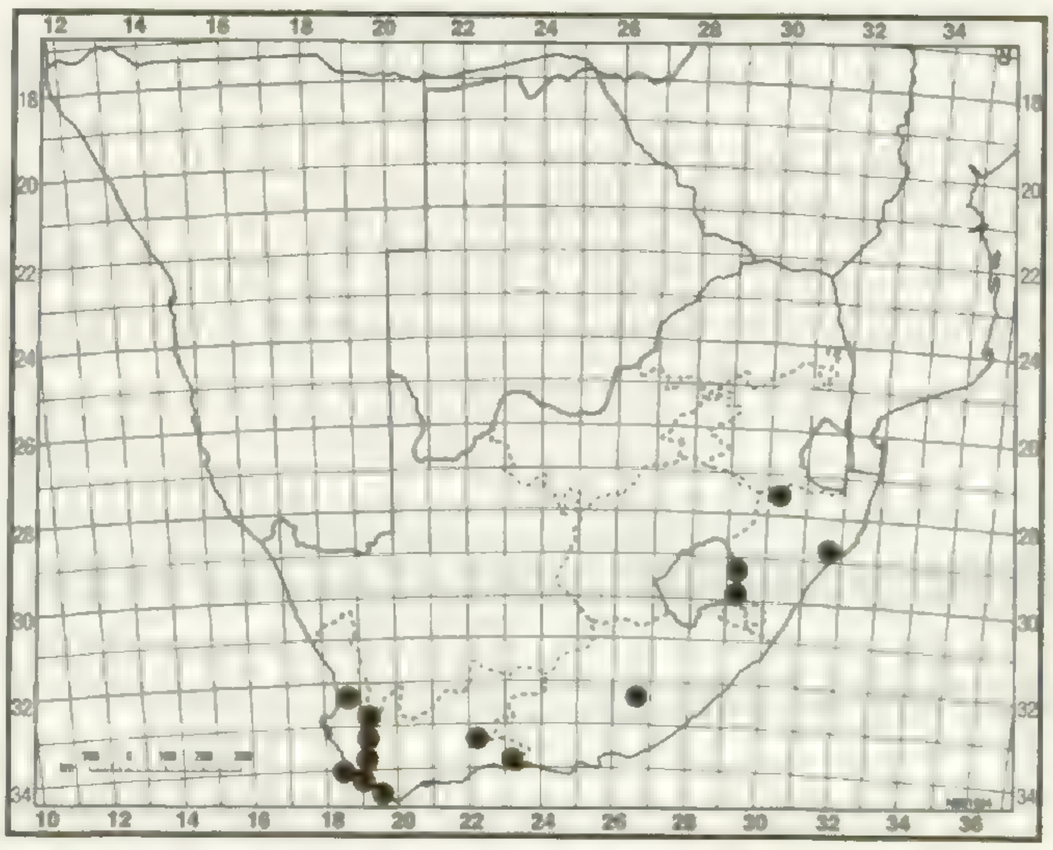
6. **Orthotrichum subexsertum** *Schimp. ex C. Müll.* in Bot. Zeitung (Berlin) 16: 164 (1858); Broth. in Natürl. PflFam., edn 2, 11: 21 (1925); Lewinsky in Bot. Tidsskr. 72: 80 (1978). Type: Cape, Genadendal, no collector given (BM!).

Orthotrichum pseudotenellum sensu Sim, Bryo. S. Afr. 275 (1926).

Plants small to medium-sized, caespitose, olivaceous or yellowish green above, greenish brown or yellowish brown to brown below; corticolous or rarely saxicolous. *Stems* 5–18 mm tall, tomentose below; in section subround to subpentagonal, central strand absent, inner cortex 7–15 cells across, thin-walled to incrassate, central cell walls occasionally collapsed, outer cortical cells smaller, in 1–3 rows, incrassate or substereids, epidermis not differentiated, outer surface ± rough. *Leaves* erect to appressed when dry, occasionally flexuose, spreading when wet; unistratose, rarely with bistratose

patches; ovate-lanceolate to lanceolate, (1.7–)1.9–3.5(–3.7) mm long; ventral surface keeled; apex acuminate, acute or rounded-obtuse, frequently channelled; margins broadly recurved to revolute, entire to crenulate below, serrulate to serrate at apex, unistratose. *Costa* ending below apex to subpercurrent; superficial cells rounded above, elongate below, flat to slightly bulging, smooth to weakly papillose; in section crescent-shaped, subround or subquadrate, bulging dorsally, cells scarcely differentiated, incrassate. *Upper laminal cells* rounded-hexagonal, incrassate, flat to bulging, 10–20 µm, smooth to papillose, papillae low, blunt; basal cells rectangular to quadrate, thin-walled to incrassate, ± flat, smooth or walls papillose, occasionally pitted. *Gemmae* fusiform, on leaf lamina or rarely terminal on rhizoid, uniseriate, up to 17 cells long, reddish brown.

Autoicous. *Perigonia* gemmate, on short or long branches; inner leaves ovate. *Perichaetia* terminal; leaves scarcely differentiated or inner leaves smaller. *Seta* (0.25–)0.6–1.1 mm long, straight or twisted anticlockwise above. *Capsule* emergent, ± cylindrical, 1.5–2.8 mm long, contracted below mouth when dry, 8-ribbed, neck differentiated; exothecial cells quadrate to rectangular, thin-walled or longitudinal walls incrassate, smaller and incrassate towards mouth, differentiated along ribs; stomata cryptopore, on base of urn and neck. *Peristome* double; exostome teeth in 8 pairs, reflexed when dry, cleft down middle, frequently perforated, triangular, (160–)210–330 µm long, brownish, densely papillose; basal membrane low, processes 8, alternating with teeth pairs, linear from broad base, 140–230 µm long, smooth or weakly papillose, striolate below,



MAP 195.—**Orthotrichum subexsertum**

pale yellow. *Operculum* conic-apiculate, 0.2–0.5 mm long. *Calyptra* 1.8–2.7 mm long, hairs uniseriate above, bi- to multiseriate below. *Spores* (12.5–)17.5–20.0(–22.5) µm, granulate. Fig. 139: 1–14.

Restricted to Africa, the species is known from Kenya, Rwanda and South Africa. *Orthotrichum subexsertum* is found on indigenous or exotic trees and shrubs and rarely on rock. In the *Flora* area most specimens have been collected in the southern and southwestern Cape regions but the species is also known from the eastern Cape, KwaZulu-Natal and Zululand. The species is often mixed with *O. diaphanum*. Map 195.

Vouchers: *Barnard PRE-CH3404; Magill 5931a; Magill & Schelpe 4026; Sim 9498; Thorne PRE-CH6420; Van Rooy 799.*

The ovate-lanceolate to lanceolate leaves with broadly recurved to revolute margins,

FIG. 139—**Orthotrichum subexsertum** (1–14): **1.** habit (dry), × 3; **2.** habit (wet), × 5; **3.** part of stem in cross section, × 175; **4.** leaf, × 35; **5.** leaf in cross section, × 175; **6.** basal leaf cells, × 350; **7.** upper laminal cells, × 350; **8.** cells at leaf apex, × 175; **9.** gemma, × 175; **10.** part of capsule wall with stoma, × 350; **11.** part of capsule mouth with peristome, × 175; **12.** operculum, × 70; **13.** calyptra, × 18; **14.** spore, × 700. **O. transvaalense** (15–22): **15.** habit (dry), × 1.4; **16.** habit (wet), × 5; **17.** leaf, × 30; **18.** leaf in cross section, × 175; **19.** upper laminal cells, × 350; **20.** leaf apex, × 175; **21.** gemma, × 175; **22.** part of capsule mouth with peristome, × 175. **O. diaphanum** (23–30): **23.** habit (dry), × 3; **24.** habit (wet), × 5; **25.** leaf, × 35; **26.** leaf in cross section, × 175; **27.** basal leaf cells (left side), × 350; **28.** leaf apex, × 175; **29.** gemma, × 175; **30.** part of capsule mouth with peristome, × 175. (1, 2 & 12, *Sim 9498*; 3, *Barnard 4965*; 4, *Wager PRE-CH12070*; 5, 7, 11 & 13, *Thorne PRE-CH6420*; 6, *Magill 4033*; 8, *Magill 4026*; 9, *Van Rooy 1499a*; 10, *Barnard 49634*; 14, *Van Rooy 799*; 15 & 16, *Magill 5051*; 17, *Van Rooy 594*; 18, *Magill 5061*; 19–22, *Smook 6416*; 23 & 24, *Van Rooy 2371*; 25 & 28, *Van Rooy 553*; 26, *Magill 4032*; 27, *Magill 6127*; 29, *Schelpe 7644*; 30, *Van Rooy 2368*.)

emergent capsule, contracted below the mouth and 8-ribbed when dry, double peristome with 8 pairs of exostome teeth and 8 narrow endostome segments, and the fusiform gemmae define this cryptopore species. The variable leaf apex can be acuminate, acute or rounded-obtuse and is frequently channelled and toothed.

7. **Orthotrichum transvaalense** *Sim*, Bryo. S. Afr. 276 (1926); Lewinsky in Bot. Tidsskr. 72: 79 (1978). Type: Transvaal, Mont. Lechlaba, Houtbosch, *Rehmann 517* (PRE!).

Plants small, loosely caespitose to caespitose, green or yellowish green above, brown-green or yellowish brown to brown below; corticolous. *Stems* 3–13 mm tall; in section subround, central strand absent or cell walls collapsed, inner cortex 6–10 cells across, thin-walled, outer cortical cells weakly differentiated, smaller, in 1 or 2 rows, firm-walled to incrassate, epidermis not differentiated. *Leaves* larger above, erect to appressed when dry, erect-spreading when wet, unistratose, concave; oblong-lanceolate, lanceolate or elliptic, (1.4–) 1.7–2.8(–4.0) mm long; ventral surface keeled; apex acute or apiculate, 60–220 µm long, cells not or weakly differentiated, rounded, incrassate, occasionally channelled; margins recurved, plane above, frequently plane below, entire, occasionally denticulate at apex, unistratose. *Costa* ending below apex; superficial cells rounded above, rectangular to linear below; in section crescent-shaped, cells scarcely differentiated, thin-walled to incrassate. *Upper laminal cells* rounded-hexagonal, thin-walled to incrassate, weakly bulging to bulging, (15.0–)17.5–22.5(–27.5) µm, smooth or weakly papillose; basal cells smooth or walls papillose, rectangular to quadrate, thin-walled or occasionally incrassate. *Gemmae* fusiform, on lamina, up to 13 cells long, brownish or reddish brown, smooth.

Autoicous. *Perigonia* gemmate, on short or numerous on long branches; inner leaves ovate. *Perichaetia* terminal; leaves scarcely differentiated, as long as stem leaves or inner leaves smaller. *Seta* short, 0.5–0.7 mm long, straight. *Capsule* emergent, ovate-cylindrical, 1.2–2.1 mm long, 8-ribbed, neck short; exothecial cells rectangular, thin-walled, weakly differentiated along ribs, rounded at mouth, incrassate; stomata cryptopore, on base of urn. *Peristome* double; exostome teeth loosely in 8 pairs, triangular, cleft almost entire length, perforated, 160–320 µm long, yellowish brown, recurved when dry, densely papillose; basal membrane absent, processes 8 or occasionally 16, linear, 1 cell wide, 130–260 µm long, yellowish or hyaline, smooth or weakly papillose. *Operculum* short conic-apiculate. *Calyptra* 1.6–2.3 mm long, smooth to scabrous above, lobed below, hairs uniseriate above, multiseriate below, denticulate. *Spores* 17–23 µm, papillose to granulate. Fig. 139: 15–22.

This endemic is rarely collected from indigenous and exotic tree trunks in the Free State, KwaZulu-Natal and the northern Transvaal region. It is frequently found mixed with *O. diaphanum*, and species of *Fabronia* Raddi and *Syntrichia* Brid. Map 194.

Vouchers: *Magill 5051; Smook 6416; Van Rooy 594.*

The species is closely related to *O. diaphanum* but can be distinguished by the wider, concave leaves, generally appressed when dry; apiculate leaf apex consisting of scarcely differentiated, rounded cells; the costa ending below the apex; and the exostome teeth loosely in 8 pairs.

8. **Orthotrichum diaphanum** *Schrad. ex Brid.*, Muscol. recent. 2,2: 29 (1801); Broth. in Natürl. PflFam., edn 2, 11: 21 (1925); Nyholm, Moss Fl. Fenn. 345 (1954); Lewinsky in Bot. Tidsskr. 72: 77 (1978); Smith, Moss Fl. Brit. Irel. 486 (1978); Crum & Anderson, Moss. E.N. Amer. 2: 696 (1981). Type: Europe.

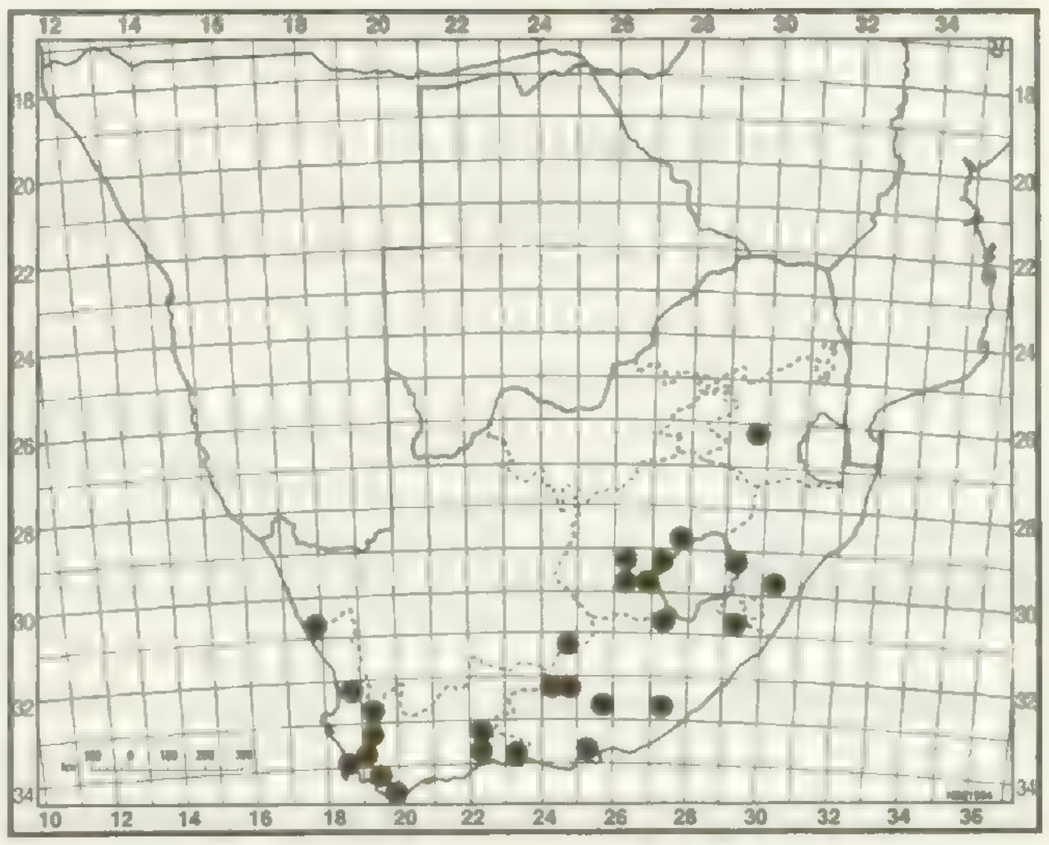
Orthotrichum glaucum Spreng., Syst. veg. 4,2: 323 (1827); Sim, Bryo. S. Afr. 275 (1926). Type: Cape, Cape Town, Table Mountain, *Ecklon s.n.* (BM!).

Orthotrichum pseudotenellum Hampe ex C. Müll. in Bot. Zeitung (Berlin) 17: 230 (1859); Broth. in Natürl. PflFam., edn 2, 11: 22 (1925). Type: Cape, Genadendal. *Breutel s.n.* (BM!).

Orthotrichum piliferum Sim, Bryo. S. Afr. 274 (1926). Lectotype: Cape, Uitenhage, *Sim 9001* (PRE!) *vide* Lewinsky in Bot. Tidsskr. 72: 77 (1978).

Plants small, loosely caespitose to caespitose, green or yellowish green above, yellowish brown to brown below; corticolous. *Stems* up to 13 mm tall, occasionally forked, scarcely tomentose below; in section subround to subpentagonal, central strand absent or cell walls collapsed, inner cortex 4–11 cells across, thin-walled to incrassate, outer cortical cells weakly differentiated, smaller, in 1 or 2 rows, incrassate, epidermis not differentiated. *Leaves* larger above, erect, frequently flexuose when dry, erect-spreading to spreading or reflexed below when wet, unistratose; ovate-lanceolate or oblong-lanceolate to lanceolate, (1.5–)1.8–2.8 (–3.0) mm long; ventral surface keeled; apex gradually or abruptly aristate, 0.1–0.5(–1.0) mm long, cells elongate, incrassate, yellowish or hyaline, occasionally channelled; margins broadly recurved to revolute, frequently plane above and below, entire, crenulate to denticulate at apex, unistratose. *Costa* merging with apical cells, occasionally ending below apex in lower leaves; superficial cells rounded above, rectangular to linear below, flat to bulging dorsally, smooth or weakly papillose; in section crescent-shaped to subround, bulging dorsally, cells scarcely differentiated. *Upper laminal cells* rounded-hexagonal, thin-walled or occasionally incrassate, thickened at the corners, bulging, 15–25(–30) µm, smooth or weakly papillose; basal cells rectangular to quadrate, smooth or walls papillose, thin-walled or occasionally incrassate. *Gemmae* fusiform, on lamina, up to 19 cells long, reddish brown, smooth.

Autoicous. *Perigonia* gemmate, on short or numerous on long branches, occasionally appearing to be on separate plants. *Perichaetia* terminal; leaves scarcely differentiated, as long as stem leaves or inner leaves smaller. *Seta* short, 0.3–0.8 mm long, ± straight. *Capsule* emergent, ovate-cylindrical, 1.2–2.1 mm long, weakly 8-ribbed, neck short; exothecial cells rectangular, thin-walled, weakly differentiated along ribs, smaller towards mouth, incrassate; stomata cryptopore, on base of urn. *Peristome* double; exostome teeth 16, narrowly subtriangular, frequently perforated above, 130–260 µm long, yellowish or brownish, recurved in old



MAP 196.—**Orthotrichum diaphanum**

capsules, densely papillose to striolate-papillose; basal membrane absent, processes 16, linear, 150–190 µm long, yellowish or hyaline, smooth to spiculose. *Operculum* conic-apiculate, 0.2–0.4 mm long, yellowish brown to brown. *Calyptra* 1.5–2.3 mm long, smooth to scabrous, hairs uniseriate above to multiseriate below, denticulate. *Spores* 13–23 µm, granulate. Fig. 139: 23–30.

Orthotrichum diaphanum is known from North and South America, Europe, the western part of temperate Asia, Macaronesia, Hawaii and northern, eastern and southern Africa. In the *Flora* area the species is most often collected in the eastern Free State and the eastern, central, southern, southwestern and northwestern Cape regions but it is also known from KwaZulu-Natal and the southern Transvaal region. Plants grow on bark of indigenous and exotic trees and shrubs, and is frequently collected with *O. subexsertum* and species of *Fabronia* Raddi and *Syntrichia* Brid. Map 196.

Vouchers: *Barnard PRE-CH8999; Magill 5848, 5914; Magill & Schelpe 4032; Van Rooy 393, 2348, 2371, 2684.*

This cryptopore species is recognized by the yellowish or hyaline awn formed by the elongated cells of the leaf apex. Also see note under *O. transvaalense* (p. 500).

Insufficiently known species

Orthotrichum afrofastigiatum C. Müll. in Hedwigia 38: 113 (1899); Broth. in Natürl. PflFam., edn 2, 11: 17 (1925); Sim, Bryo. S. Afr. 273 (1926). Type: Eastern Cape, *Mac-Owan s.n.* (H!). The name has been misapplied by Lewinsky (1978) and is regarded as a *nomen dubium* (Lewinsky & Van Rooy 1990).

4. STONEOBRYUM

Stoneobryum *Norris & Robinson* in Bryologist 84: 96 (1981). Type species: *S. bunyaense* Norris & Robinson.

Plants small; corticolous. *Stem* erect, branching by subperichaetial innovations. *Leaves* larger above, crispate dry, oblong to oblong-lingulate, base occasionally sheathing. *Costa* in section with cells scarcely differentiated. *Upper laminal cells* rounded-hexagonal, incrassate, smooth; basal cells rectangular, thin-walled to incrassate, frequently papillose. *Gemmae* absent.

Autoicous. *Perigonia* lateral, gemmate. *Perichaetia* terminal; leaves highly differentiated, hyaline, erect, enveloping capsule. *Seta* very short. *Capsule* immersed, ribbed; stomata cryptopore; annulus absent. *Peristome* double; exostome teeth in 8 pairs, triangular, minutely papillose to striolate-papillose; endostome processes narrow, keeled, alternating with teeth pairs, shorter than teeth, minutely striolate-papillose, basal membrane absent. *Operculum* short-conical. *Calyptra* mitrate, hairy. *Spores* round, minutely papillose, brownish.

The genus contains two species: *Stoneobryum bunyaense* in Australia and *S. mirum* in South Africa. The crispate leaves, the highly differentiated, hyaline perichaetial leaves enveloping the almost sessile capsule, the cryptoporous stomata, and the shortly mitrate, hairy calyptra separate *Stoneobryum* from other genera in Orthotrichoideae.

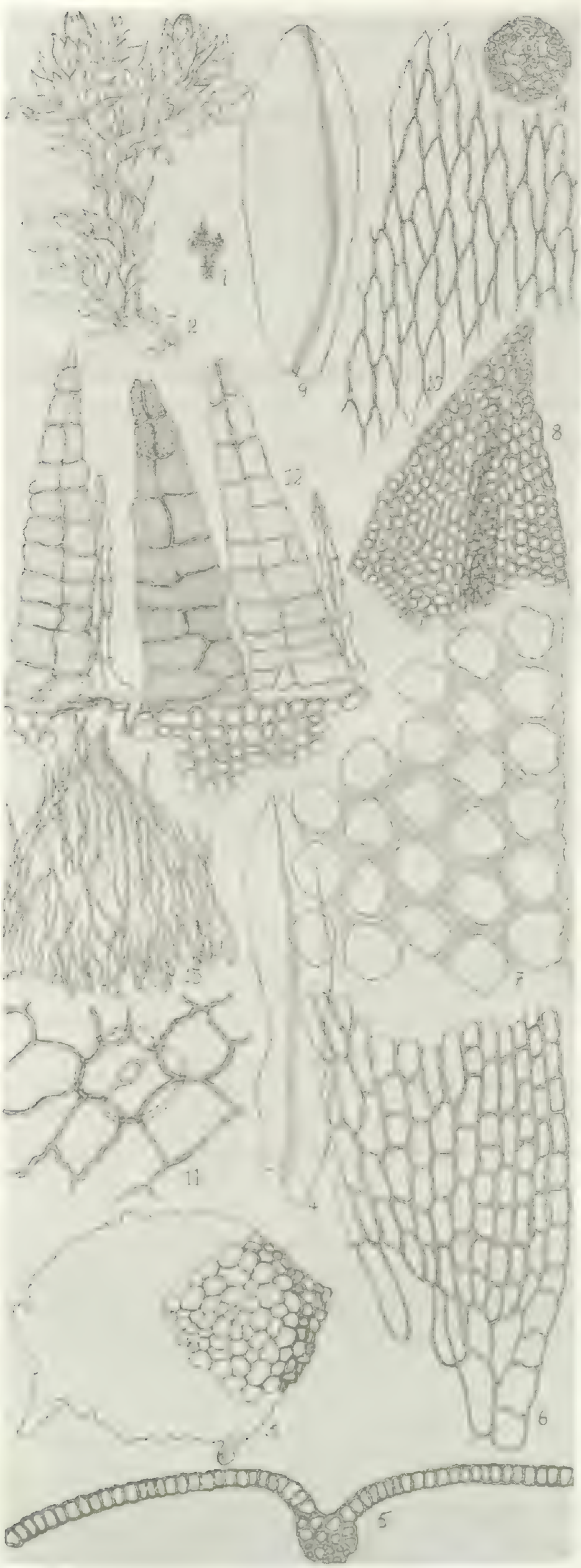
Stoneobryum mirum *(Lewinsky) Norris & Robinson* in Bryologist 84: 98 (1981). Type: Natal, Scheepers Nek, Arcadia, *Sim 10104* (PRE, holo.!).

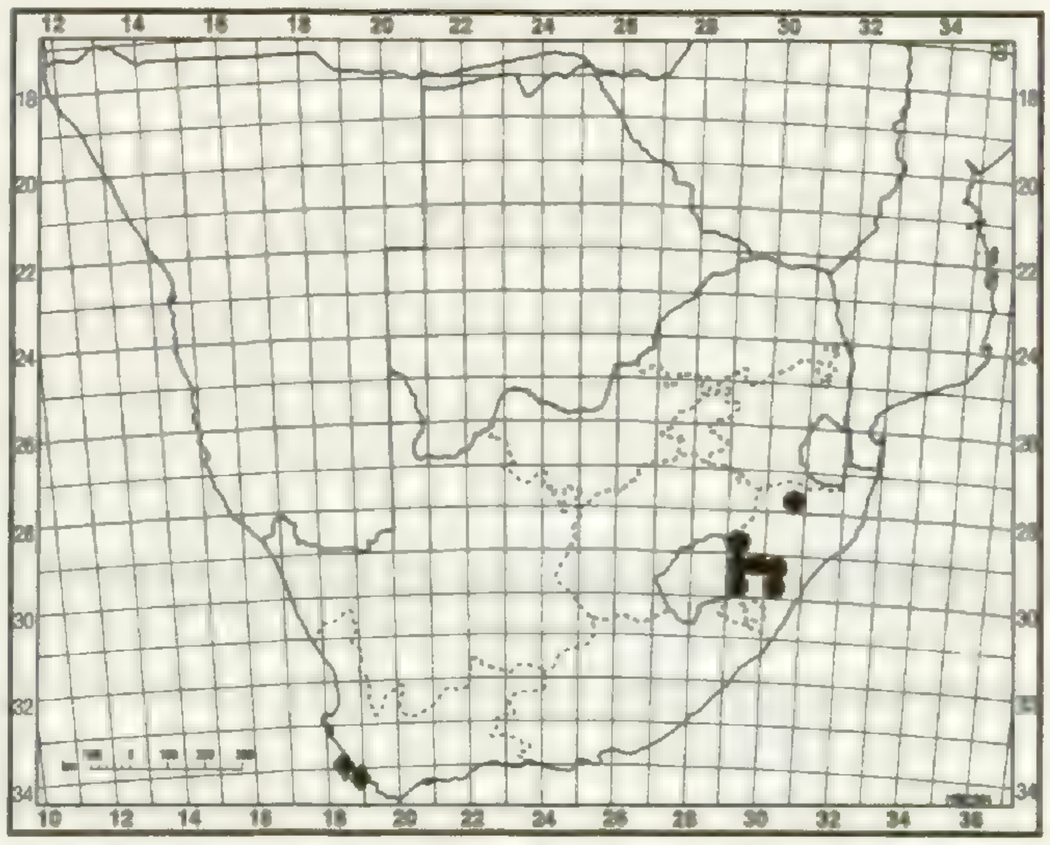
Orthotrichum mirum Lewinsky in Bot. Tidsskr. 72: 73 (1978).

Orthotrichum afrofastigiatum sensu Sim, Bryo. S. Afr. 273 (1926).

Plants small, caespitose, yellowish green or olivaceous above, brownish below; corticolous. *Stem* up to 15 mm tall, tomentose below; rhizoids reddish brown, smooth; in section with inner cortex 5–15 cells across, thin-walled to incrassate, outer cortical cells smaller, in 1–3(4) rows, incrassate or consisting of substereids or stereids. *Leaves* ± crowded, larger above, crispate dry, erect-spreading to widespreading wet, unistratose; oblong to oblong-lingulate, 1.8–3.0 mm long; ventral surface keeled; apex acute or occasionally acuminate or cuspidate; base occasionally sheathing; margins plane to recurved below, entire. *Costa* ending below apex, percurrent or infrequently mucronate; in section round, bulging dorsally, ventrally flat, laminal insertion ventral, ventral stereid band absent, 2–4 ventral cells larger, dorsal stereids or substereids present. *Upper laminal cells* rounded-hexagonal, incrassate, essentially flat, 11–19 µm, smooth; basal cells rectangular, thin-walled to incrassate, infrequently papillose.

Autoicous. *Perigonia* lateral, gemmate, leaves ovate. *Perichaetia* terminal, frequently overgrown by subperichaetial innovations; inner leaves hyaline, erect, enveloping capsule, broadly oblong, concave, apex rounded, margin plane, entire below, toothed at apex, costa ending below apex, upper laminal cells rhomboidal, hyaline, thin-walled. *Seta* very short. *Capsule* cylindrical, 1–2 mm long, abruptly narrowed to a short neck, ribbed; exothecial cells rectangular to quadrate, thin-walled to incrassate, smaller at mouth; stoma-





MAP 197.— ● **Stoneobryum mirum**
♦ **Ulota ecklonii**

ta present at base of urn. *Peristome* double; teeth 16, in 8 pairs, triangular, 240–300 µm long, brownish or yellowish, minutely papillose to striolate-papillose; endostome processes narrow, keeled, alternating with teeth pairs, shorter than teeth, minutely striolate-papillose, pale yellow, basal membrane absent. *Operculum* short-conical. *Calyptra* 0.8–1.0 mm long, hairs ascending, uniseriate, smooth. *Spores* 12–22 µm. Fig. 140.

Stoneobryum mirum is endemic to southern Africa and is found on trees in the Midlands and Drakensberg foothills of KwaZulu-Natal. Map 197.

Vouchers: *Hilliard & Burtt 13298A; Magill 5681; Sim 10102, 10103, 10109, PRE-CH7751.*

This species is most easily recognized by its highly differentiated, hyaline perichaetial leaves, enveloping the almost sessile capsule.

FIG. 140.—**Stoneobryum mirum**: **1.** habit (dry), × 1; **2.** habit (wet), × 5; **3.** stem in cross section (cells partly shown), × 130; **4.** leaf, × 18; **5.** leaf in cross section, × 175; **6.** basal leaf cells (right side), × 175; **7.** upper laminal cells at right margin, × 700; **8.** leaf apex, × 175; **9.** perichaetial leaf, × 26; **10.** perichaetial leaf cells, × 175; **11.** part of capsule wall with stoma, × 350; **12.** part of capsule mouth with peristome (papillae partly shown), × 175; **13.** calyptra, × 35; **14.** spore, × 700. (1–3, 6, 7, 9, 11 & 13, *Magill 5681*; 4 & 14, *Sim 10109*; 5, 8, 10 & 12, *Sim 10102*.)

5. ULOTA

Ulota *Mohr* in Ann. Bot. (König & Sims) 2: 540 (1806); Broth. in Natürl. PflFam., edn 2, 11: 24 (1925); Sim, Bryo. S. Afr. 272 (1926); Nyholm, Moss Fl. Fenn. 315 (1954); Sainsb., N. Zeal. mosses 217 (1955); Lawton, Moss Fl. Pacific Northwest 228 (1971); Smith, Moss Fl. Brit. Irel. 486 (1987); Crum & Anderson, Moss. E.N. Amer. 2: 720 (1981). Lectotype species: *U. crispa* (Hedw.) Brid., *vide* Gangulee, Moss. E. India 5: 1167 (1976).

Plants small, caespitose; terricolous. *Stems* erect, central strand absent. *Leaves* crowded, crisped when dry, erect-spreading when wet; linear-lanceolate above an oval or ovate base; apex acute to acuminate; base sheathing; margins generally plane, entire. *Costa* ending below apex. *Upper laminal cells* irregularly rounded, incrassate, smooth to weakly papillose; basal cells rectangular or rhomboidal to vermicular, incrassate, bordered by rectangular to quadrate cells in 4–12 rows, transverse walls incrassate, longitudinal walls thin.

Autoicous. *Perigonia* terminal on short branches. *Perichaetia* terminal, leaves weakly differentiated. *Seta* twisted anticlockwise above. *Capsule* shortly exserted, oval, contracted below mouth when dry, ribbed, neck gradually narrowed to seta; stomata present in lower half of urn, phaneropore; annulus absent. *Peristome* double; teeth 16, in 8 pairs; endostome segments linear, alternating with teeth pairs. *Operculum* conic-rostellate. *Calyptra* campanulate, lobed below, hairy. *Spores* round, granulose, brownish.

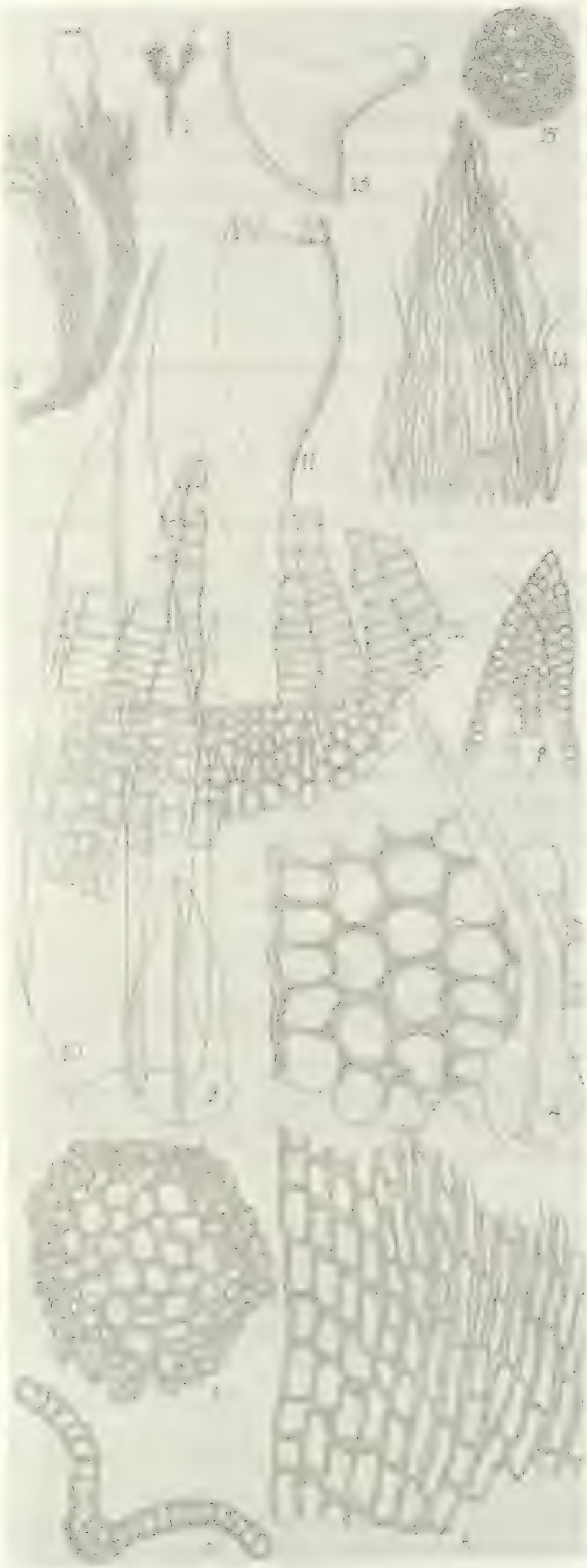
A genus of 50–60 species found mostly as epiphytes in moist temperate forests of the world. In southern Africa *Ulota* is most easily recognized by the distinct border of the differentiated leaf base.

Ulota ecklonii *(Hornsch.) Jaeg.*, Ber. Thätigk. St. Gallischen Naturwiss. Ges. 1872–1873: 163 (1874); Broth. in Natürl. PflFam., edn 2, 11: 25 (1925); Sim, Bryo. S. Afr. 273 (1926). Type: Cape, Table Mountain, *Ecklon s.n.* (BM!).

Orthotrichum ecklonii Hornsch. in Linnaea 15: 129 (1841).

Plants small, caespitose, yellow-green above, brown to reddish brown below; terricolous. *Stems* up to 18 mm tall, branching by subperichaetial innovations, tomentose below; rhizoids red-brown to brown, smooth; in section round, with inner cortex 4–8 cells across, incrassate, outer cortical cells smaller, in 1–3 rows, incrassate, outer surface rough. *Leaves* crowded, larger above, crisped when dry, erect-spreading when wet; linear-lanceolate above an oval or ovate base, (1.3–)1.5–3.0(–3.7) mm long; ventral surface keeled; apex acute to acuminate; base sheathing; margins plane, occasionally narrowly recurved in midleaf on one side, entire. *Costa* ending below apex; ventral superficial cells rectangular to linear; dorsal superficial cells oval above, narrowly rectangular to linear below; in section subround to crescent-shaped, bulging dorsally, ventrally flat, laminal insertion ventral, cells not differentiated, incrassate to stereids. *Upper laminal cells* irregularly rounded, incrassate, ± flat, smooth to weakly papillose, 10.5–16.0 (–20.0) µm, papillae low, simple, blunt; basal cells rectangular or rhomboidal to vermicular, incrassate, smooth, occasionally pitted, border distinct, cells in 4–12 rows, short-rectangular to quadrate, transverse walls incrassate, longitudinal walls thin.

Autoicous. *Perigonia* terminal on short branches, inner leaves ovate. *Perichaetia* ter-



minal, leaves weakly differentiated. *Seta* 2.0–2.5 mm long, brownish, twisted anticlockwise above. *Capsule* shortly exserted, oval, contracted below mouth when dry, ribbed, brownish, urn 1.0–1.2 mm long; neck gradually narrowed to seta, ± 0.5 mm long; exothecial cells irregularly rectangular or quadrate, smaller at mouth, irregularly rounded or oval, incrassate; stomata present in lower half of urn; annulus absent. *Peristome* reflexed when dry; exostome teeth 16, in 8 pairs, fused below, perforated above, lanceolate, 270–300 µm, yellowish brown, minutely papillose to striolate-papillose; endostome segments fragile, alternating with teeth pairs, linear, hyaline or yellowish, essentially smooth, basal membrane absent. *Operculum* 0.5 mm long. *Calyptra* 2.0–2.4 mm long, lobed below, hairs ascending, multiseriate, denticulate. *Spores* 23–35 µm. Fig. 141.

Endemic to southern Africa, *Ulota ecklonii* is known from Table Mountain and the Hottentots Holland Mountains in the Fynbos Biome of the southwestern Cape region. Map 197.

Vouchers: *Thorne PRE-CH3638; Van Zanten 7608185*.

The linear-lanceolate leaves above an ovate, bordered base; rounded, smooth to weakly papillose laminal cells; shortly exserted, ribbed capsule with a double peristome; and hairy calyptra place plants in this species.

FIG. 141.—**Ulota ecklonii**: **1.** habit (dry), × 1; **2.** habit (wet), × 5; **3.** stem in cross section, × 175; **4.** leaf, × 25; **5.** leaf in cross section, × 175; **6.** basal leaf cells (left side), × 350; **7.** upper laminal cells at left margin, × 700; **8.** leaf apex, × 175; **9.** perigonial leaf, × 35; **10.** perichaetial leaf, × 35; **11.** capsule, × 18; **12.** part of capsule mouth with peristome, × 122; **13.** operculum, × 50; **14.** calyptra, × 25; **15.** spore, × 490. (1 & 2, *Thorne PRE-CH3638*; 3, 4, 7, 8 & 10–14, *Thorne SAMH50485*; 5, 6, 9 & 15, *Ecklon s.n.*)

Subfamily MACROMITRIOIDEAE

Plants medium-sized to large; saxicolous or corticolous. *Primary stems* prostrate, with numerous erect or ascending secondary stems and branches. *Leaves* dimorphic or stem leaves scarcely differentiated, appressed or variously twisted to spirally twisted or secund when dry, ovate or variously lanceolate or oblong, base scarcely differentiated. *Upper laminal cells* rounded to rounded-quadrate or rounded-hexagonal, incrassate, smooth or papillose; basal cells scarcely differentiated or rectangular. *Gemmae* absent.

Perichaetia terminal on secondary stems and branches. Dwarf male plants frequently present in some genera. *Capsule* exserted, ribbed. *Stomata* phaneropore. *Peristome* single or double. *Calyptra* mitrate, naked or hairy. Isosporous or anisosporous.

6. MACROCOMA

Macrocoma *(Hornsch. ex C. Müll.) Grout* in Bryologist 47: 4 (1944); Vitt in Rev. Bryol. Lichénol. 39: 207 (1973); Vitt in Bryologist 83: 407 (1980a); Van Rooy & Van Wyk in Bryologist 95: 206 (1992). Type species: *M. filiforme* (Hook. & Grev.) Grout.

Macromitrium sect. *Macrocoma* Hornsch. ex C. Müll. in Bot. Zeitung (Berlin) 3: 522 (1845); Sim, Bryo. S. Afr. 278 (1926); Catcheside, Moss. S. Austr. 211 (1980). *Macromitrium* subgen. *Macrocoma* (Hornsch. ex C. Müll.) Broth. in Natürl. PflFam. 1,3: 477 (1902); Gangulee, Moss. E. India 5: 1171 (1976).

Plants medium-sized, slender, forming mats; corticolous or occasionally saxicolous. *Primary stems* creeping, irregularly or subpinnately branched; secondary stems ascending to erect, widely spaced. *Leaves* appressed to spirally appressed or rarely erect when dry, spreading to squarrose when wet; generally ovate-acuminate, lanceolate or lanceolate-ligulate; frequently excavate below, unistratose or bistratose; apex flat or occasionally cucullate, occasionally fragile; stem leaves scarcely differentiated. *Upper laminal cells* oval or rounded-quadrate, smooth above to papillose below, incrassate, frequently with intercellular spaces; basal cells scarcely differentiated.

Autoicous or dioicous. *Perigonia* terminal or lateral, leaves broadly ovate-apiculate. *Perichaetia* terminal, leaves mostly oblong. *Seta* straight or twisted counterclockwise, ochrea frequently present. *Capsule* exserted, elliptic or oblong-cylindrical, frequently ribbed; stomata present at base of urn, phaneropore. *Peristome* double, exostome parts fused, endostome parts fused. *Operculum* conic-subulate. *Calyptra* mitrate, covering capsule, naked or densely hairy, generally yellow-brown. *Spores* round, brownish, granulose; isosporous.

Of the 11 species (one with two subspecies) recognized by Vitt (1980a), four occur in Africa, three are known from southern Africa and two species are endemic to the *Flora* area. The genus is characterized by creeping, slender stems; widely spaced branches with crowded, appressed leaves; uniformly rounded to oval leaf cells; a large, mitrate, hairy calyptra covering the entire capsule; and the presence of an ochrea (a collar-like sheath around the base of the seta).

1 Branch leaf apex fragile; leaf cells generally rounded-quadrate, frequently obscure . . . . . 2. *M. lycopodioides*

1 Branch leaf apex intact; leaf cells generally oval, clear:

2 Calyptra densely hairy; Cape regions to the northern Transvaal region . . . 3. *M. tenue* subsp. *tenue*

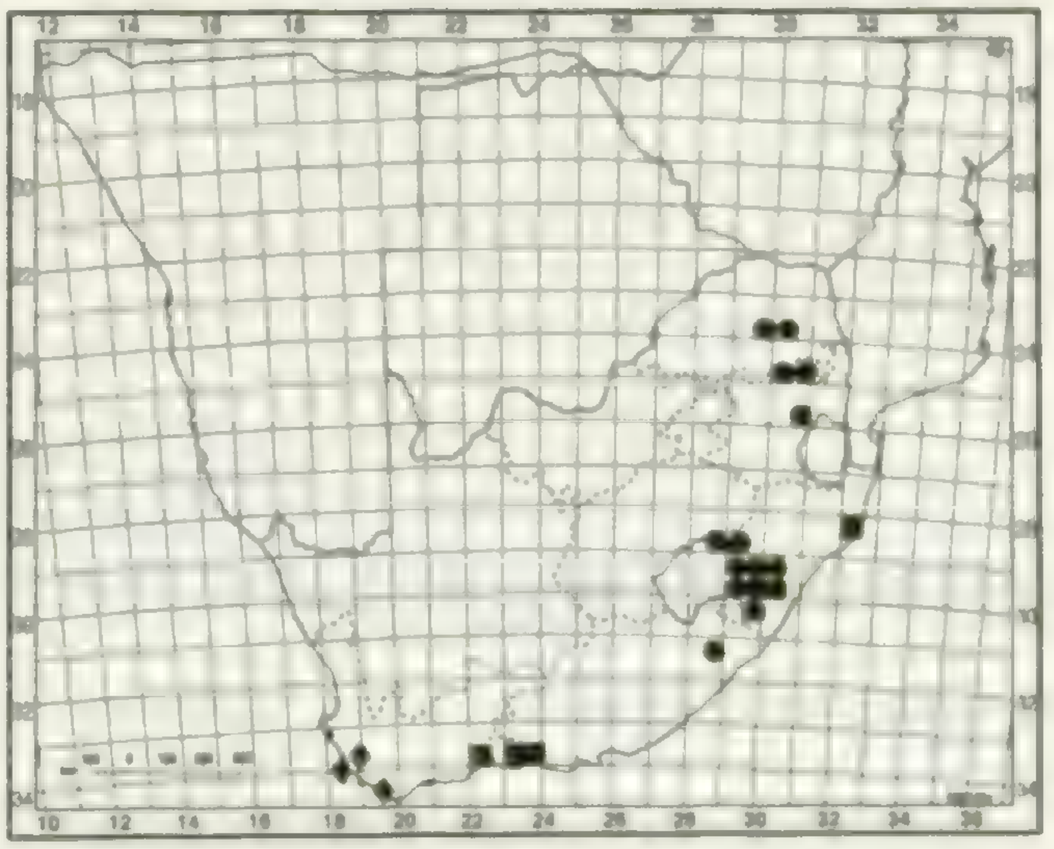
2 Calyptra naked or with a few hairs; southwestern Cape . . . . . 1. *M. pulchella*

1. **Macrocoma pulchella** *(Hornsch.) Vitt* in Rev. Bryol. Lichénol. 39: 219 (1973); Van Rooy & Van Wyk in Bryologist 95: 206 (1992). Type: Cape, *Bergius s.n.* (BM, lecto.!) *vide* Vitt in Bryologist 83: 425 (1980a).

Schlotheimia pulchella Hornsch., Horae phys. berol. 61 (1820). *Macromitrium pulchellum* (Hornsch.) Brid. in Bryol. univ. 1: 313 (1826); Broth. in Natürl. PflFam., edn 2, 11: 30 (1925); Sim, Bryo. S. Afr. 279 (1926).

Plants yellow-green or olivaceous above, brown below; corticolous. *Primary stem* up to 50 mm long, branching irregular; secondary stem in section with inner cortex 5 or 6 cells across, incrassate, outer cortical cells in 1 or 2 rows, consisting of substereids or stereids, outer surface rough. *Stem* leaves crowded to somewhat distant, frequently reflexed; ovate-acuminate, lanceolate or lanceolate-ligulate, 0.8–1.1 mm long. *Branch leaves* crowded, ± equal in size, appressed to spirally appressed or erect when dry, occasionally twisted, erect-spreading to spreading when wet; occasionally reflexed; lanceolate or oblong, 0.8–1.8 mm long, ± keeled, unistratose, occasionally with bistratose patches; apex acuminate, acute, rounded acute to obtuse, rarely cucullate; margins plane above, plane or recurved below, entire. *Costa* ending below apex to percurrent or rarely mucronate; ventral superficial cells linear, smooth; dorsal superficial cells oval above, linear below, smooth to bulging; in section crescent-shaped to subround, flat ventrally, bulging dorsally, guide cells absent, 2–4 ventral substereids or stereids present, dorsal surface cells incrassate. *Upper laminal cells* oval above, oval to rounded quadrate below, incrassate, flat to bulging above, bulging or mammillose below, occasionally with intercellular spaces, 7.5–14.0 µm; basal cells frequently longer and narrower towards costa.

Dioicous. *Perigonia* terminal on branches or branchlets, leaves broadly ovate to ovate-acuminate. *Perichaetia* terminal on branches or branchlets; leaves oblong, oblong-acuminate, oblong-lanceolate or oblong-ligulate, 1.0–1.8 mm long. *Seta* 3.2–8.0 mm long, yellowish or reddish to brown, ochrea weakly developed or absent. *Capsule* elliptic or oblong-cylindrical; urn 0.8–1.4 mm long, yellowish brown to brown, ribbed; neck 0.2–0.8 mm long; exothecial cells irregularly rectangular to quadrate, smaller at mouth, incrassate. *Peristome* double; outer layer 7–10 cells high, irregularly split, striolate-papillose, yellowish brown; inner membrane frequently plicate, outer surface smooth, inner surface coarsely papillose, hyaline. *Operculum* 0.5–0.8 mm long. *Calyptra* 1.5–1.8 mm long, naked or with a few hairs, yellow below, red-brown above. *Spores* 23–28 µm. Fig. 142: 1–16.



MAP 198.— ♦ **Macrocoma pulchella**
● **Macromitrium levatum**
■ **Macromitrium richardii**

The species is endemic to South Africa and known only from a few collection sites in the Fynbos Biome of the southwestern Cape region. Map 198.

Vouchers: *Barnard SAM no. 49635; Rehmann 164; Wood PRE-CH3401.*

Macrocoma pulchella is most easily recognized by the almost naked calyptra and the peristome of two well-developed membranes.

2. **Macrocoma lycopodioides** *(Schwaegr.) Vitt* in Rev. Bryol. Lichénol. 39: 219 (1973); Van Rooy & Van Wyk in Bryologist 95: 207 (1992). Type: Cape, Knysna, near Kruisvallei, at Mantis Station, *Burchell 5144–7*, upper left plant (G, lecto.!) *vide* Vitt in Bryologist 83: 423 (1980a).

Macromitrium lycopodioides Schwaegr. in Sp. musc. frond. suppl. 2,2: 141 (1827); Broth. in Natürl. PflFam., edn 2, 11: 30 (1925); Sim, Bryo. S. Afr. 279 (1926). *Macromitrium tenue* var. *lycopodioides* (Schwaegr.) C. Müll. in Bot. Zeitung (Berlin) 3: 522 (1845).

Plants yellowish green or olivaceous above, brown below; corticolous or occasionally saxicolous. *Primary stem* up to 90 mm long, branches irregular, young stem often subpinnately branched; secondary stem in section with inner cortex 5–9 cells across, incrassate, outer cortical cells in 1–4 rows, consisting of substereids or stereids, outer surface rough. *Stem leaves* crowded to somewhat distant, frequently reflexed; ovate-acuminate or lanceolate, 0.4–1.1 mm long. *Branch leaves* crowded, ± equal in size, appressed to spirally appressed when dry, spreading to widely spreading when wet, occasionally reflexed; lanceolate, 0.5–1.0 mm long, keeled to narrowly keeled above, broadly keeled below; bistratose or occasionally unistratose with bistratose patches or unistratose; apex acuminate to acute, occasionally cucullate, fragile; margins plane above, plane to recurved below, entire above, entire or occasionally crenulate to denticulate below. *Costa* ending below apex to percurrent; ventral superficial cells rectangular or linear; dorsal superficial cells oval or rounded-quadrate above, linear below, smooth to bulging; in section crescent-shaped to subround, flat ventrally, bulging dorsally, guide cells absent, incrassate or consisting of 2–4 ventral substereids or stereids, dorsal surface cells incrassate. *Upper laminal cells* rounded-quadrate, frequently obscure, homogeneous, incrassate, flat to bulging above, frequently mammillose to papillose below, intercellular spaces numerous, 7.5–14.0 µm; basal cells frequently longer and narrower towards costa.

Dioicous. *Perigonia* terminal on branches or branchlets or lateral on short branchlets, leaves broadly ovate-acuminate to ovate-apiculate. *Perichaetia* terminal on branches or branchlets; leaves oblong-acuminate or oblong-subulate, 1.8–2.3 mm long. *Seta* 1.8–4.0 mm long, yellowish or reddish brown to brown, ochrea frequently present. *Capsule* elliptic or oblong-cylindrical; urn 1.0–1.6 mm long, yellowish brown to brown, smooth, ribbed, neck up to 0.5 mm long; exothecial cells irregularly rounded to rectangular, smaller at mouth, incrassate. *Peristome* double; outer layer low, fused, pale brown, coarsely papillose; inner membrane low, outer surface smooth, inner surface coarsely papillose, hyaline. *Operculum* 0.7–0.8 mm long. *Calyptra* 2.2–2.8 mm long, yellow to yellow-brown to brown, densely hairy. *Spores* 23–35 µm. Fig. 142: 17–24.

Endemic to the *Flora* area, *M. lycopodioides* is known from the southwestern, southern and eastern Cape regions, the Free State, KwaZulu-Natal, Zululand, Swaziland, and the eastern, central and northern Transvaal areas. Map 199.

Vouchers: *Crosby & Crosby 7641, 8085; Magill 3500, 5932, 5995; Smook 1846; Van Rooy 2287; Von Breitenbach 488.*

This species is easily distinguished from the closely related *M. tenue* by its fragile leaf apex. The obscure, rounded-quadrate laminal cells of the branch leaves with numerous intercellular spaces, and the oblong-subulate perichaetial leaves also help to identify *M. lycopodioides*. Vitt (1980b) suggests that the fragile leaf apex and intercellular spaces are caused by the breakdown of components of the middle lamella.

FIG. 142.—**Macrocoma pulchella** (1–16): **1.** habit (dry), × 1; **2.** habit (wet), × 7; **3.** stem in cross section, × 175; **4.** stem leaf, × 35; **5.** branch leaf, × 35; **6.** leaf in cross section, × 175; **7.** basal leaf cells (right side), × 350; **8.** upper laminal cells (right side), × 350; **9.** leaf apex, × 350; **10.** perigonial leaf, × 35; **11.** perichaetial leaf, × 35; **12.** part of capsule wall with stoma, × 350; **13.** part of capsule mouth with peristome, × 175; **14.** operculum, × 35; **15.** calyptra, × 25; **16.** spore, × 700. **M. lycopodioides** (17–24): **17.** habit (dry), × 1; **18.** habit (wet), × 7; **19.** stem leaf, × 35; **20.** branch leaves, × 35; **21.** leaf in cross section, × 175; **22.** basal leaf cells, × 350; **23.** upper laminal cells, 350; **24.** perichaetial leaf, × 35. **M. tenue** subsp. **tenue** (25–32): **25.** habit (dry), × 1; **26.** habit (wet), × 5; **27.** stem leaf, × 35; **28.** branch leaf, × 35; **29.** leaf in cross section, × 175; **30.** upper laminal cells, × 700; **31.** leaf apex, × 350; **32.** perichaetial leaf, × 35. (1, 2, 4 & 14, *Barnard SAMH49635*; 3, 6, 9, 11, 15 & 16, *Wood PRE-CH3401*; 5, 7, 8, 12 & 13, *Rehmann 164*; 10, *Wood SAMH50327*; 17 & 18, *Leighton PRE-CH12797*; 19 & 20, *Von Breitenbach 488*; 21, *Magill 5932*; 22, *Magill 3500*; 23, *Van Rooy 2287*; 24, *Crosby 7641*; 25, *Smook 1413*; 26, *Von Breitenbach 334a*; 27 & 32, *Von Breitenbach 198*; 28 & 31, *Oliver 7665*; 29, *Van Rooy 798*; 30, *Hilliard & Burtt 10438*.)

3. **Macrocoma tenue** *(Hook. & Grev.) Vitt* subsp. **tenue** in Rev. Bryol. Lichénol. 39: 217 (1973); Van Rooy & Van Wyk in Bryologist 95: 208 (1992). Type: Cape of Good Hope, *Menzies s.n.* (BM, lecto.!) *vide* Vitt in Bryologist 83: 425 (1980a).

Orthotrichum tenue Hook. & Grev. in Edinburgh J. Sci. 1: 120 (1824). *Macromitrium tenue* (Hook. & Grev.) Brid. in Bryol. univ. 1: 740 (1826); Broth. in Natürl. PflFam., edn 2, 11: 30 (1925); Sim, Bryo. S. Afr. 280 (1926); Scott & Stone, Moss. S. Austr. 232 (1976); Catcheside, Moss. S. Austr. 212 (1980).

Orthotrichum microphyllum Hook. & Grev. in Edinburgh J. Sci. 1: 121 (1824). *Macromitrium microphyllum* (Hook. & Grev.) Brid. in Bryol. univ. 1: 737 (1826). Type: Cape, *Burchell s.n.* (E, lecto.!) *vide* Vitt in Bryologist 83: 427 (1980a).

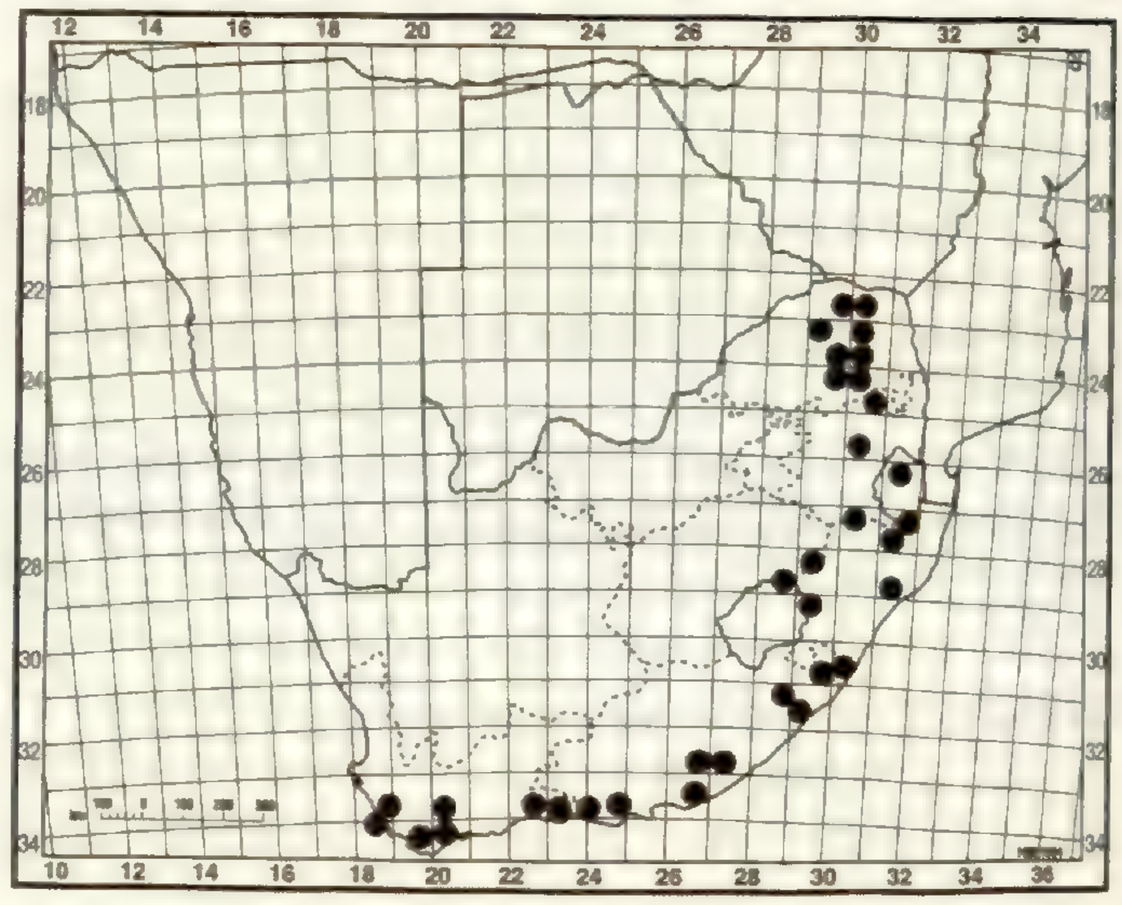
Maschalocarpus ecklonii Spreng. in Syst. veg. 4,2: 321 (1827). Type: Cape, Table Mountain, *Ecklon s.n.* (H, lecto.!) *vide* Vitt in Bryologist 83: 428 (1980a).

Macromitrium dregei Hornsch. in Linnaea 15: 131 (1841). *Macromitrium tenue* var. *dregei* (Hornsch.) C. Müll. in Bot. Zeitung (Berlin) 3: 522 (1845). Type: Cape, *Drège s.n.* (BM, lecto.!) *vide* Vitt in Bryologist 83: 428 (1980a).

Macromitrium confusum Mitt. in J. Linn. Soc., Bot. 22: 305 (1886). Type: Cape, East London, *Capt. Rooper s.n.* (NY, lecto.!) *vide* Vitt in Bryologist 83: 428 (1980a).

Macromitrium dawsoniaemitrium C. Müll. in Hedwigia 38: 116 (1899). Type: Cape, in sylvis Knysna, *Rehmann 160*, (H, lecto.!) *vide* Vitt in Bryologist 83: 428 (1980a).

Leiomitrium capense Broth. in Denkschr. Kaiserl. Akad. Wiss., Math.-Naturwiss. Kl. 88: 736 (1913). *Coleochaetium capense* (Broth.) Broth. in Natürl. PflFam., edn 2, 11: 26 (1925). Type: Cape, slope of Table Mountain, 1909, *Brunnthaler s.n.* (H, holo.!) *vide* Vitt in J. Hattori Bot. Lab. 49: 110 (1981).



MAP 199.—**Macrocoma lycopodioides**

Plants yellowish green to dark green or olivaceous above, dark green or brown below; corticolous, occasionally saxicolous. *Primary stem* up to 150 mm long, branches irregular; secondary stem in section with inner cortex 6–10 cells across, incrassate, outer cortical cells in 2–4 rows, incrassate or consisting of substereids or stereids, outer surface rough. *Stem leaves* crowded to somewhat distant, frequently reflexed; ovate-acuminate to lanceolate or lanceolate-ligulate, 0.5–1.7 mm long. *Branch leaves* crowded, ± equal in size, appressed to spirally appressed when dry, erect-spreading to widely spreading when wet, occasionally reflexed, infrequently falcate; lanceolate, lanceolate-ligulate or infrequently lanceolate-subulate, 0.5–1.6 mm long, frequently narrowly keeled above, broadly keeled below, unistratose, frequently with bistratose patches above; apex acuminate, acute or rounded acute, occasionally cucullate; margins plane above, plane to recurved below, entire above, entire below or denticulate at base. *Costa* ending below to percurrent or infrequently mucronate; ventral superficial cells narrowly rectangular or linear; dorsal superficial cells oval above, linear below, smooth to bulging; in section crescent-shaped to subround, flat ventrally, bulging dorsally, guide cells absent, 2–4 ventral substereids, stereids or incrassate cells present, dorsal surface cells incrassate. *Upper laminal cells* oval to rounded, homogeneous, incrassate, flat to bulging above, frequently mammillose to papillose below, frequently with intercellular spaces below, 6–18 µm; basal cells frequently longer and narrower towards costa.

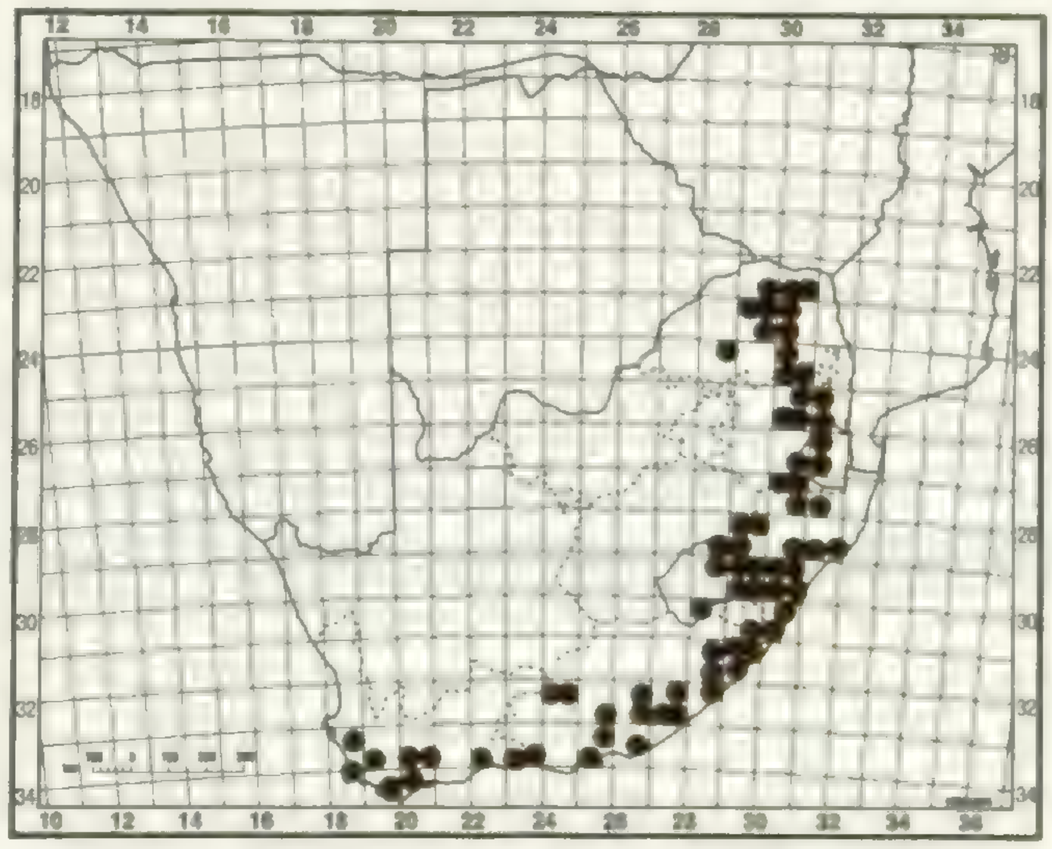
Autoicous. *Perigonia* terminal on branches or branchlets, leaves broadly ovate-apiculate. *Perichaetia* terminal on branches or branchlets; leaves oblong-ligulate, oblong-lanceolate or lanceolate, infrequently falcate, 1.3–2.3 mm long. *Seta* 2.5–7.5 mm long, yellowish brown or reddish brown to brown, ochrea frequently present. *Capsule* elliptic or oblong-cylindrical; urn 1–2 mm long, yellowish brown or reddish

brown to brown, smooth to ribbed; neck 0.2–0.6 mm long; exothecial cells irregularly oval to rectangular, smaller at mouth, incrassate. *Peristome* double; outer layer 2–5 cells high, fused, coarsely papillose, pale brown; inner membrane low, outer surface smooth, inner surface coarsely papillose, hyaline. *Operculum* 0.4–1.0 mm long. *Calyptra* 2–4 mm long, yellow to yellowish brown to brown, densely hairy. *Spores* (18–)27–37(–43) µm. Fig. 142: 25–32.

This subspecies is known from central, eastern and southern Africa, Réunion, Madagascar, St. Helena, Australia, Tasmania and New Zealand. In the *Flora* area it is found on trees and occasionally rocks in the Fynbos Biome of the southern and southwestern Cape and montane forest and grassland of the central and eastern Cape regions, the Free State, Lesotho, KwaZulu-Natal, Zululand, Swaziland and the eastern, central and northern Transvaal areas. Map 200.

Vouchers: *Hilliard & Burtt 14087; Kemp 855; Magill 4557, 5701; Smook 1672; Stirton 8132; Van Rooy 801, 1414, 1895; Von Breitenbach 198.*

Macrocoma tenue is recognized by the densely hairy calyptra, slender branches with



MAP 200.—**Macrocoma tenue** subsp. **tenue**

appressed leaves, intact leaf apex, small laminal cells which are oval with incrassate walls, and the low exostome and endostome membranes. The autoicous sexual condition of *M. tenue* subsp. *tenue* also helps to distinguish it from *M. pulchella* and *M. lycopodioides*. Vitt (1980c) has shown that *M. tenue* can be divided into two subspecies and southern African plants belong to subspecies *tenue*.

7. MACROMITRIUM

Macromitrium *Brid.*, Muscol. recent. suppl. 4: 132 (1818); Broth. in Natürl. PflFam., edn 2, 11: 28 (1925); Sim, Bryo. S. Afr. 278 (1926) p.p.; Van Rooy & Van Wyk in Bryologist 95: 208 (1992). Type species: *M. pallidum* (P. Beauv.) Wijk & Marg. *vide* Vitt in J. Hattori Bot. Lab. 54: 5 (1983).

Plants medium-sized to large, forming mats; corticolous or saxicolous. *Primary stems* creeping; secondary stems erect, crowded, bushy. *Leaves* secund or variously twisted when dry; narrowly oblong-lanceolate or ligulate; unistratose, occasionally with bistratose patches or irregularly unistratose to multistratose; apex obtuse, acute or acuminate, infrequently fragile; margins plane or recurved on one side, entire or crenulate or denticulate, prorate or tuberculate; stem leaves smaller, generally lanceolate. *Costa* strong, single. *Upper laminal cells* rounded, incrassate, flat to mammillose, smooth or multipapillose; basal laminal cells rectangular, occasionally sinuate, longitudinal walls strongly incrassate, frequently tuberculate.

Autoicous or pseudautoicous, dwarf male plants axillary on secondary stem or on leaf lamina. *Perichaetia* terminal, overgrown by subperichaetial innovations; leaves oblong-lanceolate or oblong-subulate, unistratose. *Seta* occasionally twisted clockwise above. *Capsule* exserted, erect, ovate-cylindrical, smooth or ribbed; stomata present on neck, phaneropore. *Peristome* single or double; exostome teeth 16, separate or fused, segments and cilia absent, basal membrane absent or

high. *Operculum* conic-rostrate. *Calyptra* large, mitrate, laciniate to lacerate below, plicate, naked or with a few hairs. *Spores* round, brownish, anisosporous or isosporous.

A large tropical to temperate genus of approximately 370 species, most of them occurring in Oceania, southeastern Asia, Australasia and tropical South America. The genus is absent from Europe and large parts of Asia and North America.

Members of the genus can be recognized by: 1. creeping primary stem with numerous erect bushy branches; 2. differentiated stem leaves; 3. branch leaves that are variously twisted when dry; 4. small, rounded upper laminal cells; 5. differentiated perichaetial leaves; 6. erect, frequently plicate capsules; 7. reduced peristomes; 8. sexual condition that is frequently pseudautoicous and plants that are frequently anisosporous; and 9. large, mitrate, plicate, laciniate to lacerate calyptrae.

1 Branch leaves 2.5–5.0 mm long; margins irregularly denticulate towards apex; peristome double . . . . . 1. *M. levatum*
1 Branch leaves 1.0–3.0 mm long; margins entire, weakly prorate or crenulate-papillose towards apex; peristome single:
2 Branch leaves with upper laminae irregularly unistratose to multistratose; apex fragile . . . . . 5. *M. serpens*
2 Branch leaves with upper laminae unistratose, occasionally with bistratose patches; apex intact:
3 Branch leaf apex acute to acuminate; basal cells reaching midleaf; upper cells flat to bulging, smooth . . . . . 2. *M. macropelma*
3 Branch leaf apex broadly acute to rounded-obtuse; basal cells restricted to lower quarter to third of leaf; upper cells strongly bulging, multipapillose:
4 Branch leaves frequently with bistratose patches; perichaetial leaves longer than branch leaves; seta 1.5–3.5 mm long; pseudautoicous, anisosporous . . . . 4. *M. lebomboense*
4 Branch leaves unistratose; perichaetial leaves shorter or as long as branch leaves; seta 4.5–12.0 mm long; autoicous, isosporous . . . . . 3. *M. richardii*

1. **Macromitrium levatum** *Mitt.* in J. Linn. Soc., Bot. 7: 152 (1863); Broth. in Natürl. PflFam., edn 2, 11: 43 (1925); Van Rooy & Van Wyk in Bryologist 95: 208 (1992). Type: Cameroon, Cameroon Mountain, 8 000–10 000 ft, on trees and rocks, *Mann s.n.* (NY-Mitt., holo.!).

Macromitrium mannii sensu Sim, Bryo. S. Afr. 281 (1926).

Plants medium-sized to large, forming mats, green, yellowish green, brown-green, or yellow-brown above, brown below; saxicolous or corticolous. *Primary stem* up to 140 mm long, branching regularly, tomentose below; rhizoids smooth, red-brown; secondary stem erect, 2–40 mm tall, branching by subperichaetial innovations; in section inner cortex 10–16 cells across, incrassate, outer cortical cells smaller, in 2–5 rows, incrassate, substereids or stereids, outer surface rough. *Stem leaves* crowded to ± distant, fragile on old stems; ovate-acuminate, ovate-lanceolate or ovate-subulate, 1.0–2.4 mm long. *Branch leaves* crowded, erect, spirally twisted to contorted when dry, erect-spreading, frequently reflexed, flexuose when wet, rugose, unistratose; narrowly lanceolate, narrowly oblong-lanceolate or narrowly oblong-subulate, 2.7–4.8 mm long, keeled; apex acute to acuminate; margins plane, occasionally reflexed below, irregularly denticulate above, plane or prorate to tuberculate below. *Costa* ending below apex to mucronate; ventral and dorsal superficial cells linear, smooth; in section crescent-shaped to subround, bulging dorsally, guide cells incrassate or substereids, dorsal stereids present. *Upper laminal cells* rounded or rounded-hexagonal, incrassate, bulging, frequently in conspicuous longitudinal rows, 7.5–18.0 µm, mammillose to strongly mammillose; basal cells long-rectangular, longitudinal

walls irregularly incrassate, pitted, tuberculate, marginal cells frequently thinner walled, inflated, smooth or prorate to tuberculate.

Pseudautoicous; dwarf male plants rare, on branch leaf lamina. *Perichaetia* terminal, frequently overgrown by subperichaetial innovations; leaves oblong-lanceolate or oblong-subulate, 3.2–4.4 mm long. *Seta* 4.5–14.0 mm long, yellowish brown or reddish brown to brown. *Capsule* reddish brown to brown, ribbed; urn ovate-cylindrical, 1.0–1.6 mm long; neck to 0.5 mm long; exothecial cells irregular in shape, smaller at mouth, incrassate; annulus deciduous, cells subrectangular. *Peristome* double, erect when dry; exostome teeth fused, blunt, frequently fragile above, 170–225 µm long, yellow-brown to brown, densely papillose-striolate; basal membrane high, hyaline, papillose, segments and cilia absent. *Operculum* 1.0–1.2 mm long. *Calyptra* 3.0–3.6 mm long, lacerate to base of rostrum, essentially naked, yellow to yellowish brown or reddish brown. *Spores* 17.0–36.5 µm, minutely papillose; anisosporous. Fig. 143: 1–13.

Macromitrium levatum is widespread in Africa south of the Sahara, and is also found on the Comoros and Madagascar. In the *Flora* area it is found on stems and branches of trees and shrubs and on rock in montane forests and wooded areas of the eastern Cape, KwaZulu-Natal and the eastern and northern Transvaal regions. Map 198.

Vouchers: *Crosby & Crosby 9216; Esterhuysen 20218; Magill 5512, 6566; Rankin 148; Smook & Phelan 876; Van Rooy 1417, 1604, 2299.*

The species is most easily identified by the large plants with long, spirally twisted and contorted branch leaves. The unistratose branch leaves with denticulate upper margins, bulging upper laminal cells arranged in conspicuous longitudinal rows, tuberculate basal laminal cells, calyptra that is lacerated to the base of the rostrum, and the double peristome also help to place plants of *M. levatum*.

Tixier (1989) placed this species in synonymy under the Asian *Macromitrium sulcatum* (Hook.) Brid. but until the type specimens are compared, *M. levatum* is here maintained as a distinct species.

2. **Macromitrium macropelma** *C. Müll.* in Bot. Zeitung (Berlin) 14: 420 (1856); Broth. in Natürl. PflFam., edn 2, 11: 34 (1925); Sim, Bryo. S. Afr. 283 (1926). Lectotype: Cape, Grootvadersbosch, *Ecklon* (PRE!) *fide* Van Rooy & Van Wyk in Bryologist 95: 210 (1992).

Plants medium-sized to large, forming mats, yellow-green above, brown below; corticolous. *Primary stem* up to 60 mm long, branching regularly, tomentose below; rhizoids smooth, reddish brown; secondary stem 4–14 mm tall, branching by subperichaetial innovations; in section inner cortex 10–12 cells across, incrassate, outer cortical cells smaller, in 1–3 rows, stereids, outer surface rough. *Stem leaves* ± distant, ovate-acuminate or ovate-subulate or shortly oblong-subulate, 1.0–1.7 mm long. *Branch leaves* crowded, erect-twisted to spirally twisted when dry, erect to erect-spreading when wet, ± rugose, unistratose; narrowly lanceolate, narrowly oblong-lanceolate or narrowly oblong-subulate, 1.5–2.3 mm long, keeled; apex acute to acuminate; margins plane, occasionally recurved on one side of leaf, entire to weakly prorate. *Costa* ending below apex to mucronate; dorsal and ventral superficial cells linear, smooth; in section subround to round, bulging dorsally, cells undifferentiated, stereids. *Upper laminal cells* irregularly rounded to oval, incrassate, flat to bulging, 7.5–18.0 µm, smooth; basal cells long-rectangular to linear, longitudinal walls strongly incrassate, smooth.

Pseudautoicous? *Perigonia* not seen. *Perichaetia* terminal, frequently overgrown by subperichaetial innovations; leaves lanceolate, oblong-lanceolate, or oblong-acuminate, 2.2– 2.8 mm long. *Seta* 8–13 mm long, reddish brown to brown. *Capsule* reddish brown to brown, mouth darker, weakly ribbed above; urn ovate-cylindrical, 1.0–1.2 mm long; neck up to 0.4 mm long, wrinkled when dry; exothecial cells irregularly quadrate to rectangular, smaller at mouth, incrassate. *Peristome* single; exostome teeth 16, loose-

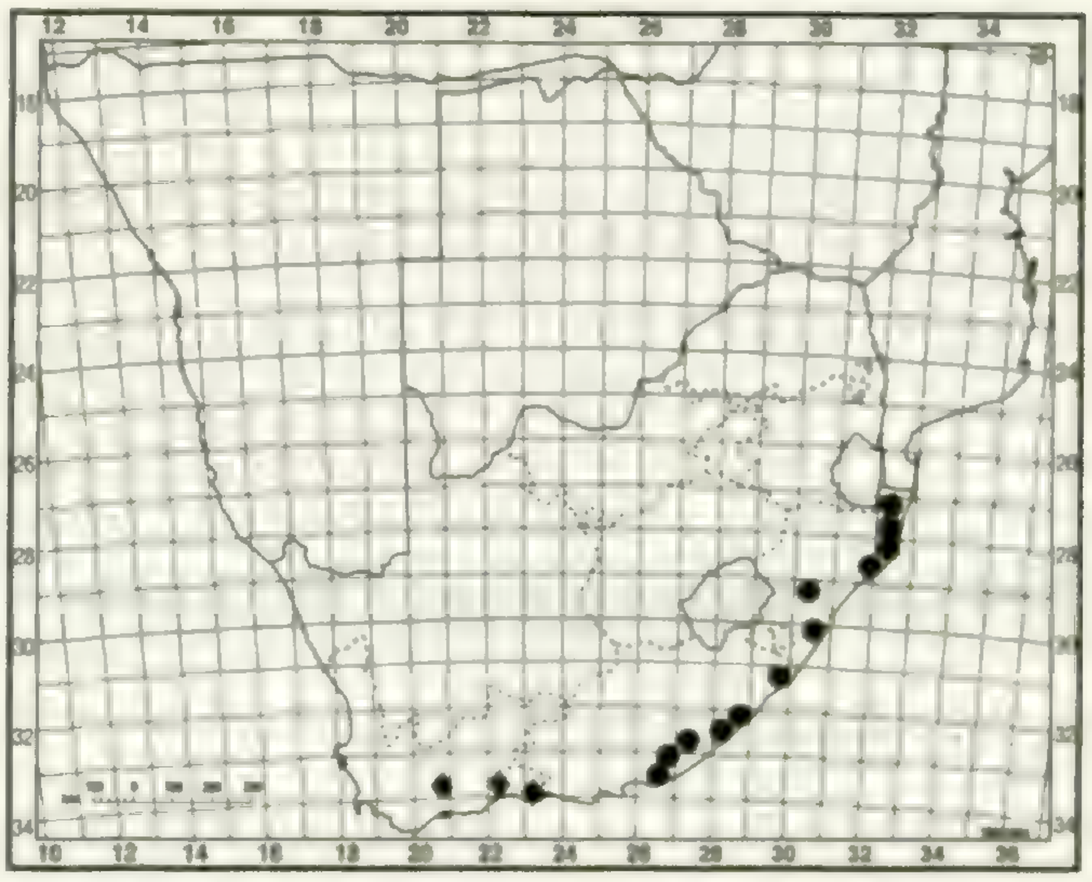
FIG. 143.—**Macromitrium levatum** (1–13): **1.** habit (dry), × 1; **2.** habit (wet), × 5; **3.** branch in cross section, × 175; **4.** stem leaf, × 35; **5.** branch leaf, × 35; **6.** branch leaf cross section, × 175; **7.** basal cells of branch leaf, × 350; **8.** upper laminal cells of branch leaf, × 350; **9.** branch leaf apex, × 350; **10.** perichaetial leaf, × 35; **11.** sporophyte, × 5; **12.** part of capsule mouth, × 175; **13.** spores, × 700. **M. richardii** (14–25): **14.** habit (dry), × 1; **15.** habit (wet), × 5; **16.** stem leaf, × 35; **17.** branch leaf, × 35; **18.** branch leaf in cross section, × 175; **19.** basal cells of branch leaf, × 350; **20.** upper laminal cells of branch leaf, × 350; **21.** cells of branch leaf apex, × 350; **22.** perichaetial leaf, × 35; **23.** part of capsule mouth with peristome, × 175; **24.** calyptra, × 18; **25.** spore, × 700. (1, *Smook & Phelan 876*; 2, *Magill 5598*; 3, *Sim PRE-CH9021*; 4, *Vorster 587*; 5–7, *Crosby 9216*; 8, *Vorster 500*; 9, *Von Breitenbach 447*; 10–13, *Esterhuysen 20218*; 14, 15, 17 & 23, *Magill 6035*; 16, 18 & 22, *Magill 6074*; 19–21, *Wagener PRE-CH13349*; 24 & 25, *Thorne SAMH49510*.)

ly in 8 pairs, narrowly oblong, blunt, frequently irregular in outline, (85–) 120–190 µm long, pale brown, finely papillose. *Operculum* 0.8 mm long. *Calyptra* mitrate, 2.2–2.5 mm long, laciniate below, essentially naked, yellowish brown. *Spores* 25–48 µm, minutely granulose; anisosporous. Fig. 144: 1–14.

Endemic to southern Africa, *Macromitrium macropelma* is found on trees or rock in a few localities in the southern and southwestern Cape. Map 201.

Vouchers: *Barnard SAM no. 49291; Rehmann 167; Van Zanten 7609424.*

The slender, unistratose branch leaves with smooth, flat to bulging and strongly incrassate upper laminal cells and smooth basal laminal cells separate specimens of *M. macropelma* from the other species of *Macromitrium* in the *Flora* area. Dwarf male plants were not found but the presence of anisomorphic spores suggests a pseudautoicous sexual condition.



MAP 201.— ♦ **Macromitrium macropelma**
● **Macromitrium lebomboense**

3. **Macromitrium richardii** *Schwaegr.*, Sp. musc. frond. suppl. 2,2: 188 (1827); Broth. in Natürl. PflFam., edn 2, 11: 34 (1925); Crum & Anderson, Moss. E.N. Amer. 2: 736 (1981); Van Rooy in J. Bryol. 16: 213 (1990). Type: Guiana, *Richard s.n.* (G, holo.).

Plants medium-sized, forming mats, olivaceous or yellowish green above, reddish brown to brown below; corticolous. *Primary stem* tomentose below; rhizoids smooth, reddish brown; secondary stems numerous, 2–10 mm tall, branching by subperichaetial innovations; in section inner cortex 9–11 cells across, incrassate, outer cortical cells smaller, in 1 or 2 rows, consisting of substereids or stereids, outer surface rough. *Stem leaves* secund, ovate-lanceolate or lanceolate, 0.75–1.4 mm long. *Branch leaves* ± crowded, tightly inrolled, twisted when dry, erect-spreading, incurved when wet, occasionally rugulose, unistratose; narrowly lanceolate or ligulate, (1.4–)1.6–2.8 mm long, ventral surface keeled; apex acute, obtuse or mucronate, weakly cucullate; margins plane or recurved on one side, crenulate. *Costa* ending below apex to subpercurrent or occasionally mucronate, superficial cells linear; in section round, bulging dorsally, consisting of substereids or stereids. *Upper laminal cells* rounded-hexagonal to rounded, incrassate, bulging, (8.7–)10.0–15.0 µm, smooth to multipapillose, papillae low, blunt; basal cells smooth, rarely papillose below, elliptical to rectangular, incrassate, frequently pitted.

Autoicous. *Perigonia* on short or long branches. *Perichaetia* terminal; leaves oblong-lanceolate or lanceolate, as long as branch leaves. *Seta* 4.5–7.5(–12.0) mm long, yellowish or reddish brown. *Capsule* ovate-cylindrical, 1.2–1.8 mm long, reddish brown, weakly to strongly 8-ribbed; mouth contracted, 8-ribbed; neck differentiated; exothecial cells irregularly rounded-quadrate to rectangular, incrassate, smaller at mouth. *Peristome* single, reduced, inserted below mouth; teeth 16, oblong, blunt, 55–150 µm long, yellowish brown or pale yellow, striolate papillose. *Operculum* 0.8 mm long. *Calyptra* naked or sparsely hairy, lacerate below, 2.0–2.3 mm long. *Spores* 21–34 µm, densely papillose; isosporous. Fig. 143: 14–25.

This African-Neotropical disjunct is known from North, Central and South America, and the Caribbean. In Africa, *Macromitrium richardii* is

found on tree branches in lowland forests and wooded areas of the southern Cape and Zululand. Map 198.

Vouchers: *Magill 5363, 6035a, 6074; Thorne SAM No. 49510; Wagener PRE-CH13349.*

This species can be identified by the tightly inrolled, ligulate-lanceolate branch leaves with acute to obtuse apices, strongly bulging, generally multipapillose laminal cells, and the 8-ribbed capsule with a contracted mouth. Compared with the closely related *M. lebomboense*, this species has narrower branch leaves, shorter perichaetial leaves and calyptra, a longer seta, an autoicous sexual condition and isomorphic spores.

4. **Macromitrium lebomboense** *Van Rooy* in J. Bryol. 16: 209 (1990). Type: Natal, Lebombo Mountains, near Nambulugwana, *Van Rooy 227* (PRE, holo.!).

Plants medium-sized, forming mats, yellowish green or greenish brown above to brown below; corticolous or rarely saxicolous. *Primary stem* tomentose below; rhizoids smooth, reddish brown to brown; secondary stems numerous, 2–8 mm tall, branching by subperichaetial innovations; in section inner cortex 9–13 cells across, incrassate, outer cortical cells smaller, in 1–4 rows, consisting of stereids, outer surface rough. *Stem leaves* secund, lanceolate, 0.8–1.5(–1.8) mm long. *Branch leaves* crowded, tightly inrolled, twisted when dry, erect-spreading when wet, rugulose below, unistratose or frequently with bistratose patches; generally ligulate, (1.2–)1.6–2.3(–2.5) mm long; ventral surface keeled; apex rounded-obtuse; margins plane, frequently recurved on one side. *Costa* ending below to percurrent; superficial cells linear, bulging; in section subround, bulging dorsally, consisting of stereids. *Upper laminal cells* small, rounded-hexagonal to rounded-quadrate, incrassate, bulging, 7.5–10.0 µm, papillae low, blunt, scattered over lumen; basal cells smooth, rarely papillose below, rectangular, longitudinal walls incrassate, frequently sinuate.

Pseudautoicous; dwarf male plants axillary, rarely on leaf base, 0.5–1.2 mm long, branching by subperigonial innovations. *Perichaetia* terminal; leaves erect, longer than branch leaves, broadly lanceolate or oblong-lanceolate, (2.0–)2.2–2.8(–3.1) mm long. *Seta* (1.7–)2.2–2.8(–3.1) mm long, yellowish brown or reddish brown. *Capsule* ovate-cylindrical, (1.2–)1.5–1.8(–2.0) mm long, yellowish brown or reddish brown, weakly ribbed dry, mouth erect, neck differentiated; exothecial cells irregularly quadrate to rectangular, incrassate, smaller at mouth. *Peristome* single, inserted below mouth; teeth 16, occasionally in pairs, narrowly oblong, blunt, 155–250 µm long, yellowish, papillose-striolate. *Operculum* 1.0–1.3 mm long. *Calyptra* 2.5–3.5 mm long, deeply plicate, lacerate below, naked or sparsely hairy. *Spores* 12.0–30.0(–36.0) µm, minutely papillose; anisosporous. Fig. 144: 23–31.

Macromitrium lebomboense is endemic to southern Africa and is found on tree trunks and branches and rarely on rock in lowland forests and wooded streams of Zululand, KwaZulu-Natal, and the eastern Cape region. Map 201.

FIG. 144.—**Macromitrium macropelma** (1–14): **1.** habit (dry), × 1; **2.** habit (wet), × 4; **3.** part of branch in cross section, × 175; **4.** stem leaf, × 35; **5.** branch leaf, × 35; **6.** branch leaf in cross section, × 175; **7.** basal cells of branch leaf, × 350; **8.** upper laminal cells of branch leaf, × 350; **9.** branch leaf apex, × 350; **10.** perichaetial leaf, × 35; **11.** part of capsule wall with stoma, × 350; **12.** part of capsule mouth with peristome teeth, × 175; **13.** calyptra, × 18; **14.** spore, × 700. **M. serpens** (15–22): **15.** habit (dry), × 1; **16.** habit (wet), × 4; **17.** stem leaf, × 35; **18.** branch leaf, × 35; **19.** branch leaf in cross section, × 175; **20.** basal cells of branch leaf, × 350; **21.** dwarf male plant at base of branch leaf, × 35; **22.** Spores (papillae partly shown), × 700. **M. lebomboense** (23–31): **23.** habit (dry), × 1; **24.** habit (wet), × 5; **25.** branch in cross section (cells partly shown), × 130; **26.** stem leaf, × 35; **27.** branch leaf, × 35; **28.** branch leaf in cross section, × 175; **29.** upper laminal cells of branch leaf at left margin, × 700; **30.** perichaetial leaf, × 35; **31.** Spores (papillae partly shown), × 700. (1–3 & 5–14, *Barnard SAMH49291*; 4, *Sim PRE-CH9017*; 15, *Schelpe 7886*; 16, *Van Zinderen Bakker 264*; 17 & 20, *Oliver 7056*; 18, *PRE-CH10726*; 19, *Jacot Guillarmod 6164a*; 21, *Rehmann PRE-CH5717*; 22, *Rehmann 157*; 23, 24 & 30, *Van Rooy 227*; 25, *Bosman PRE-CH1576*; 26, *Wager PRE-CH12021*; 27, *Van Rooy 196*; 29 & 31, *Smook 1523*.)

Vouchers: *Bosman PRE-CH1576; Linder 1191; Magill 5321; Smook 1523; Van Rooy 948, 1714.*

Related to *Macromitrium richardii* (see p. 515), *M. lebomboense* can be recognized by the perichaetial leaves that are longer than the branch leaves, short seta, weakly ribbed capsule with erect mouth, well-developed exostome of 16 teeth, deeply plicate, lacerate, naked to sparsely hairy calyptra, and anisomorphic spores with correlated pseudautoicous sexual condition.

5. **Macromitrium serpens** *(Hook. & Grev.) Brid.* in Bryol. univ. 1: 736 (1826); Broth. in Natürl. PflFam., edn 2, 11: 35 (1925); Sim, Bryo. S. Afr. 282 (1926). Lectotype: Cape, *Burchell s.n.* (E!; BM, isolecto.!) *fide* Van Rooy & Van Wyk in Bryologist 95: 210 (1992).

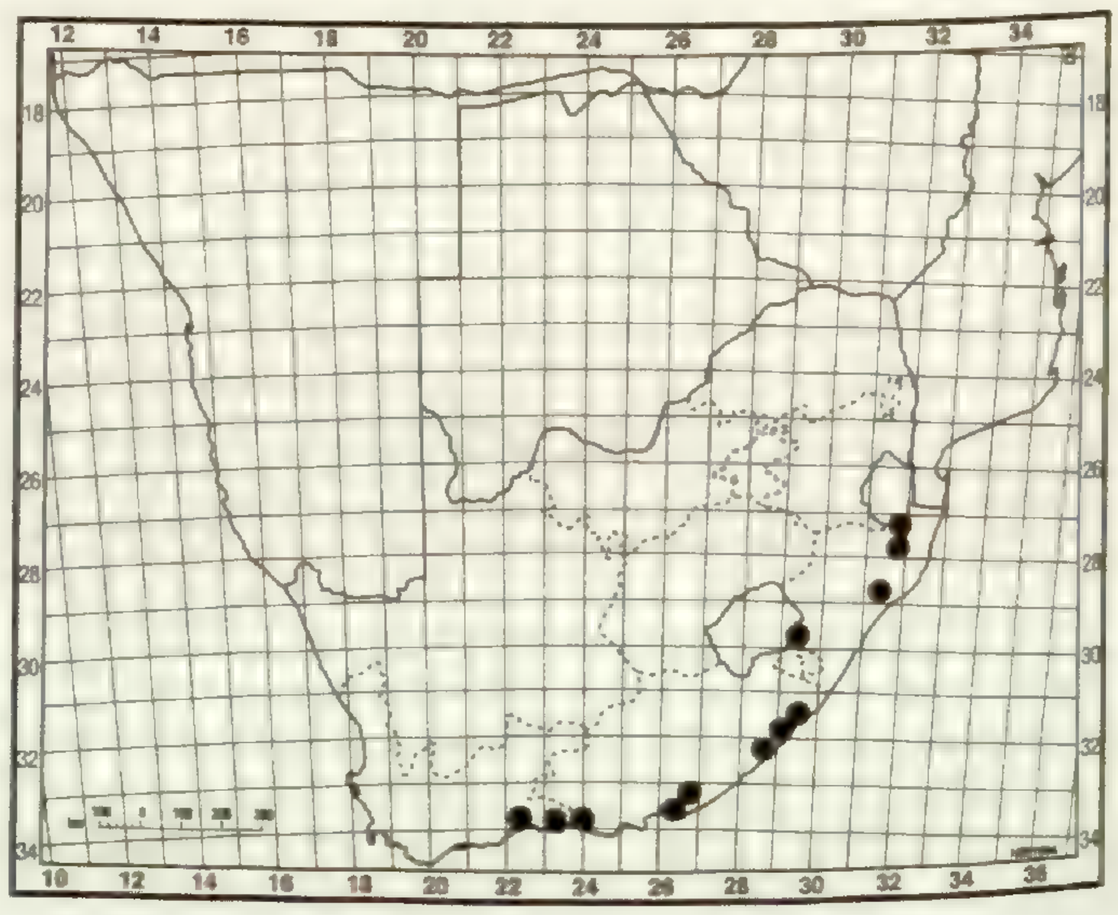
Orthotrichum serpens Bruch ex Hook. & Grev. in Edinburgh J. Sci. 1: 119 (1824).

Macromitrium tristratosum Dix. in Kongel. Norske Vidensk. Selsk. Skr. (Trondheim) 1932, 4: 10 (1932). Lectotype: Natal, Zululand, Eshowe, indigenous forest, *Höeg 121* (BM!) *fide* Van Rooy & Van Wyk in Bryologist 95: 210 (1992).

Plants medium-sized to large, forming mats, yellowish green, green or greenish brown above, greenish brown to brown below; corticolous. *Primary stem* up to 100 mm long, branching regularly, tomentose below; rhizoids smooth, reddish brown; secondary stem 2–10 mm tall, branching by subperichaetial innovations; in section inner cortex 10–15 cells across, incrassate, outer cortical cells smaller, in 1–3 rows, consisting of substereids to stereids, outer surface rough. *Stem leaves* crowded to ± distant, fragile on old stems; ovate-acuminate or ovate-subulate, 1.0–2.3 mm long. *Branch leaves* crowded, erect, curved to twisted, inrolled when dry, erect-spreading, inflexed when wet, ± rugose, irregularly unistratose to multistratose; narrowly ovate-lanceolate, narrowly lanceolate or narrowly lanceolate-subulate, 1.7–3.0 mm long, keeled; apex acuminate, fragile; margins plane, entire to crenulate-papillose above, entire below. *Costa* ending below apex to percurrent, ventral and dorsal superficial cells linear, smooth; in section subround to round, bulging dorsally, guide cells frequently differentiated, incrassate, dorsal stereids present. *Upper laminal cells* rounded, incrassate, bulging, 8.7–15.0 µm, multipapillose, papillae small, low; basal cells rectangular, longitudinal walls incrassate, straight to sinuate, frequently unipapillose or tuberculate.

Pseudautoicous; dwarf male plants on secondary stem, leaves ovate or ovate-apiculate. *Perichaetia* terminal, overgrown by subperichaetial innovations; leaves oblong-lanceolate, 1.6–2.7 mm long, unistratose. *Seta* 3.5–6.0 mm long, reddish brown. *Capsule* reddish brown, mouth darker, smooth to weakly ribbed above; urn ovate-cylindrical, 0.8–1.4 mm long; neck up to 0.4 mm long, wrinkled dry; exothecial cells irregularly quadrate to rectangular, smaller at mouth, incrassate. *Peristome* single; exostome teeth 16, narrowly oblong, blunt, frequently irregular in outline, (125–)150–225 µm long, pale yellow or yellowish brown, hyaline above, erect to incurved dry, striolate-papillose. *Operculum* 0.8–1.0 mm long. *Calyptra* 2.8–3.2 mm long, lacerate below, plicate, essentially naked, yellow to yellowish brown below, yellowish brown or reddish brown above. *Spores* 16–38 µm, minutely papillose; anisoporous. Fig. 144: 15–22.

Macromitrium serpens is known from eastern and southern Africa, Madagascar and the Mascarenes. In the *Flora* area it is found on



MAP 202.—**Macromitrium serpens**

stems and branches of trees and rarely on rock in indigenous forests of the southern and eastern Cape regions, KwaZulu-Natal Midlands and Zululand. Map 202.

Vouchers: *Crosby & Crosby 8060; Magill 5166, 6035; Oliver, Balsinhas & Vorster 7056; Russell 2689; Schelpe 7886; Van Rooy 888, 2066.*

The species is recognized by its fragile leaf apex, sinuate basal laminal cells and papillose, irregularly unistratose to multistratose upper leaf lamina. The structure of the upper leaf lamina is unusual in that the cells are displaced in dorsal and ventral 'pillars'. The laminal cells are also arranged in longitudinal rows, giving the leaf a lamellate appearance.

8. SCHLOTHEIMIA

Schlotheimia *Brid.*, Muscol. recent. suppl. 2: 16 (1812); Broth. in Natürl. PflFam., edn 2, 11: 46 (1925); Sim, Bryo. S. Afr. 284 (1926); Bartram, Mosses of the Philippines 184 (1939); Sainsb., N. Zeal. mosses 238 (1955); Gangulee, Moss. E. India 5: 1190 (1976); Crum & Anderson, Moss. E.N. Amer. 2: 741 (1981); Van Rooy & Van Wyk in Bryologist 95: 210 (1992). Lectotype species: *S. torquata* (Hedw.) Brid. *fide* E.G. Britton, Bahama Flora (1920).

Plants medium-sized to large, forming mats or cushions, greenish or olivaceous or brownish green above, orange-brown or reddish brown below; saxicolous or corticolous. *Primary stem* prostrate; secondary stems erect, crowded, bushy. *Leaves* crowded, appressed and twisted to spirally twisted around stem when dry, erect-spreading to squarrose when wet, rugose; oblong, oblong-lingulate or oblong-lanceolate; apex acute, subacute, rounded-obtuse or cuspidate; stem leaves smaller, shortly oblong or ovate to lanceolate. *Costa* ending below apex, mucronate or cuspidate. *Upper laminal cells* rounded-hexagonal, incrassate, ± flat, smooth; basal cells rhomboidal to rectangular, incrassate, pitted.

Pseudautoicous or dioicous, dwarf male plants axillary on secondary stems. *Perigonia* terminal. *Perichaetia* terminal; leaves oblong, oblong-lanceolate or lanceolate. *Seta* twisted clockwise above. *Capsule* exserted, erect, ovoid or oblong-cylindrical, weakly to strongly ribbed; stomata on neck and base of urn, phaneropore. *Peristome* double, well-developed; exostome teeth 16, consisting of 2 divisions; endostome segments 16–32, narrow, alternating with exostome teeth, shorter than teeth, basal membrane low. *Operculum* conic-rostrate. *Calyptra* large, completely covering capsule, campanulate, lobed below, naked. *Spores* round, brownish; isosporous or anisosporous.

A genus of ± 130 species mostly found in tropical and subtropical regions. The tropical forests of South America are the major centre of described species, 28 species are known from Madagascar and 19 from Africa. *Schlotheimia* is recognized by the rusty or chestnut-green and brown colour of the plants; prostrate stems with erect, bushy branches; differentiated stem leaves; crowded, rugose branch leaves that are twisted to spirally twisted around the branch when dry; the large, naked, bell-shaped calyptra, lobed below and covering the whole capsule; and the well-developed peristome.

1 Stem leaf costa aristate; dioicous; isosporous . . . . . 3. *S. rufopallens*
1 Stem leaf costa ending below the apex, mucronate or short-excurrent; pseudautoicous; anisosporous:
2 Branch leaves broad towards apex; apex acute to rounded-obtuse; costa mucronate . . . . . 1. *S. ferruginea*
2 Branch leaves gradually narrowed to the cuspidate apex; costa ending below the apex or exserted as a short point . . . . . 2. *S. percuspidata*

1. **Schlotheimia ferruginea** *(Bruch ex Hook. & Grev.) Brid.* in Bryol. univ. 1: 743 (1826); Broth. in Natürl. PflFam., edn 2, 11: 48 (1925); Sim, Bryo. S. Afr. 286 (1926). Lectotype: Cape, *Burchell s.n.* (E!; BM, isolecto.!) *fide* Van Rooy & Van Wyk in Bryologist 95: 212 (1992).

Orthotrichum ferrugineum Bruch ex Hook. & Grev. in Edinburgh J. Sci. 1: 118 (1824). *Macromitrium ferrugineum* (Bruch ex Hook. & Grev.) C. Müll. in Bot. Zeitung (Berlin) 3: 544 (1845).

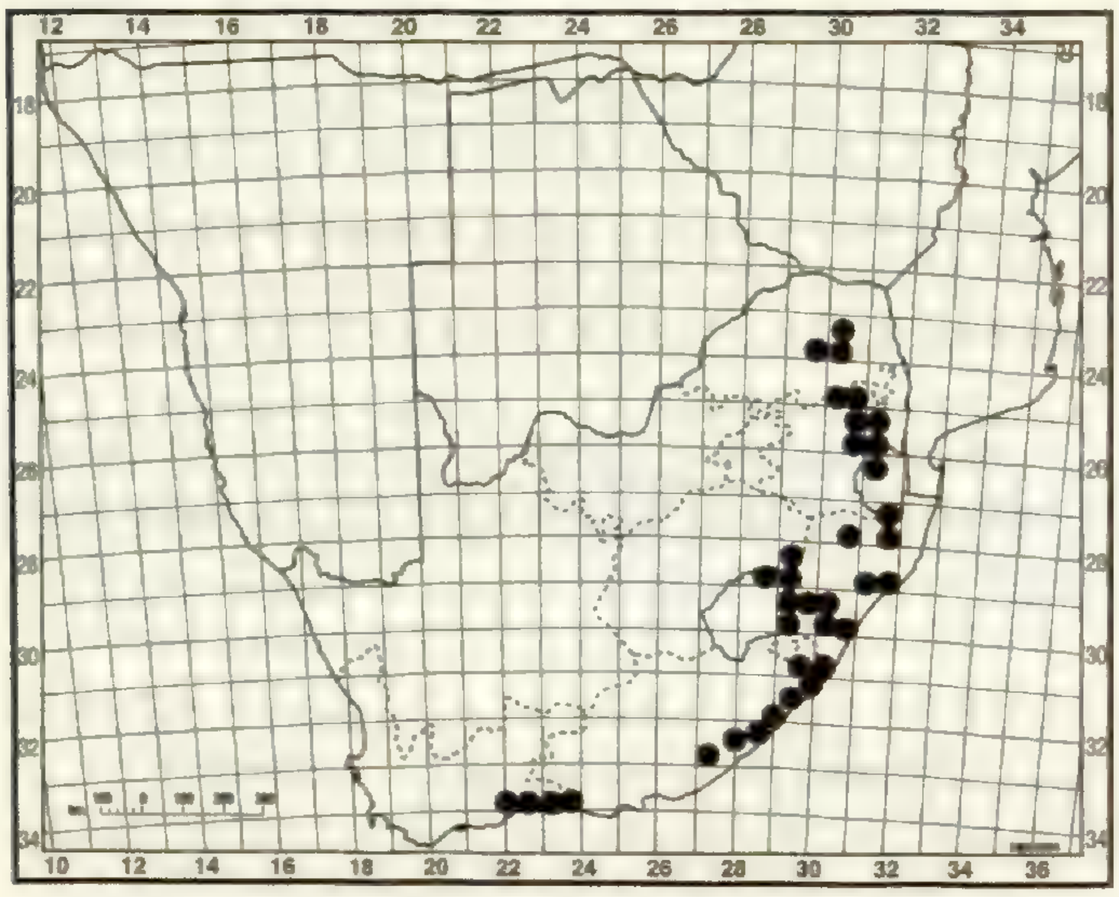
Schlotheimia subventrosa Broth. & Bryhn in Forh. Vidensk.-Selsk. Kristiania 4: 13 (1911). Type: Zululand, Eshowe, Aug. 1909, *H. Bryhn s.n.* (H, holo.!).

Plants medium-sized to large, forming mats or cushions, green to brownish green above, brown, orange-brown or reddish brown below; saxicolous or corticolous. *Primary stem* up to 120 mm long, branching regularly, frequently tomentose; rhizoids essentially smooth, brown to reddish brown; secondary stem up to 35 mm tall, branching by subperichaetial innovations; in section inner cortex 7–10 cells across, incrassate, outer cortical cells smaller, in 1–3 rows, consisting of substereids to stereids, outer surface occasionally rough. *Stem leaves* crowded to ± distant; ovate to lanceolate or shortly oblong, 0.5–1.5 mm long; apex acute to obtuse; margins frequently decurrent; costa mucronate to short-excurrent, awn up to 260 µm long. *Branch leaves* crowded, ± equal in size, appressed and twisted to spirally twisted around stem when dry, erect-spreading when wet, rugose; broadly oblong to oblong-lingulate, 1.0–2.5 mm long; ventral surface keeled; apex broadly acute to rounded obtuse; margins plane, entire. *Costa* mucronate; in section round, lamina ventrally inserted, 2 ventral cells larger, consisting of stereids, dorsal surface rough. *Upper laminal cells* rounded-hexagonal to rounded, incrassate, ± flat, 7.5–15.0 µm, smooth; basal cells narrowly rhomboidal to narrowly rectangular, incrassate, pitted.

Pseudautoicous; dwarf male plants axillary on secondary stem. *Perichaetia* terminal, frequently overgrown by subperichaetial innovations; leaves broadly oblong to oval or oblong-lanceolate, 1.8–3.2 mm long. *Seta* 1.4–4.5 mm long, yellowish brown or reddish. *Capsule* oblong-cylindrical, brown to red-brown, smooth to weakly ribbed; urn 1.4–2.5 mm long; neck 0.2–0.4 mm long, frequently wrinkled dry; exothecial cells irregular in shape, incrassate, smaller and occasionally transversely elongate at mouth. *Peristome* double; exostome teeth 16, revolute dry, linear, consisting of 2 divisions, 300–455 µm long, brown, densely striolate-papillose; endostome segments 16–32, outer surface smooth, inner surface vertically striolate-papillose, yellow to pale yellowish brown. *Operculum* 1 mm long. *Calyptra* 3.2–4.0 mm long, yellow to brown or reddish brown. *Spores* 13–40 µm, granulate or minutely papillose; anisosporous. Fig. 145: 1–14.

Schlotheimia ferruginea is the most frequently collected species of the genus in the *Flora* area. It is found on stems and branches of trees and shrubs and on rock in forests and wooded areas of the northern and eastern Transvaal regions, Swaziland, Zululand, KwaZulu-Natal and the eastern Cape region, and occasionally in the southern Cape. This African

FIG. 145.—**Schlotheimia ferruginea** (1–14): **1.** habit (dry), × 3; **2.** habit (wet), × 5; **3.** branch in cross section (cells partly shown), × 175; **4.** stem leaf, × 35; **5.** stem leaf apex, × 175; **6.** branch leaf, × 35; **7.** branch leaf in cross section, × 175; **8.** basal cells of branch leaf at right margin, × 700; **9.** upper laminal cells of branch leaf, × 700; **10.** branch leaf apex, × 175; **11.** perichaetial leaf, × 35; **12.** part of capsule mouth with peristome (papillae partly shown), × 175; **13.** calyptra, × 12; **14.** spores (papillae partly shown), × 700. **S. percuspidata** (15–22): **15.** habit (dry), × 1; **16.** habit (wet), × 3; **17.** stem leaf, × 35; **18.** stem leaf apex, × 175; **19.** branch leaf, × 35; **20.** branch leaf apex, × 175; **21.** perichaetial leaf, × 35; **22.** Spores (papillae partly shown), × 700. **S. rufopallens** (23–30): **23.** habit (dry), × 5; **24.** habit (wet), × 2; **25.** stem leaf, × 35; **26.** stem leaf apex, × 175; **27.** branch leaf, × 35; **28.** branch leaf apex, × 175; **29.** perichaetial leaf, × 35; **30.** spore, × 700. (1, 2 & 10, *Hilliard & Burtt 11841b*; 3, *Van Rooy 114*; 4, *Retief & Herman 42*; 5 & 14, *Wells 75*; 6 & 13, *Van Rooy 2161*; 7, *Von Breitenbach 95*; 8 & 9, *Magill 5514*; 11, *Von Breitenbach 102*; 12, *Hoffman 41*; 15 & 16, *Stirton 9813*; 17, *Van Rooy 1645*; 18 & 19, *Magill 5510*; 20, *Von Breitenbach 466*; 21, *Magill 5216*; 22, *Smook 904*; 23, *Smook 6190*; 24, *Von Breitenbach 414*; 25, *Magill 6190*; 26, *Jacot Guillarmod PRE-CH13540*; 27, *Schelpe 7871*; 28, *Sim 9288*; 29, *Cooper 17*; 30, *Pillans PRE-CH6261*.)



MAP 203.—**Schlotheimia ferruginea**

endemic is also known from Tanzania, Zambia and Zimbabwe. Map 203.

Vouchers: *Crosby & Crosby 9201; Hilliard & Burtt 11841B; Kemp 1053; Magill 5514, 6576; Stirton 8690; Van Rooy 1188, 1883, 2161; Von Breitenbach 121.*

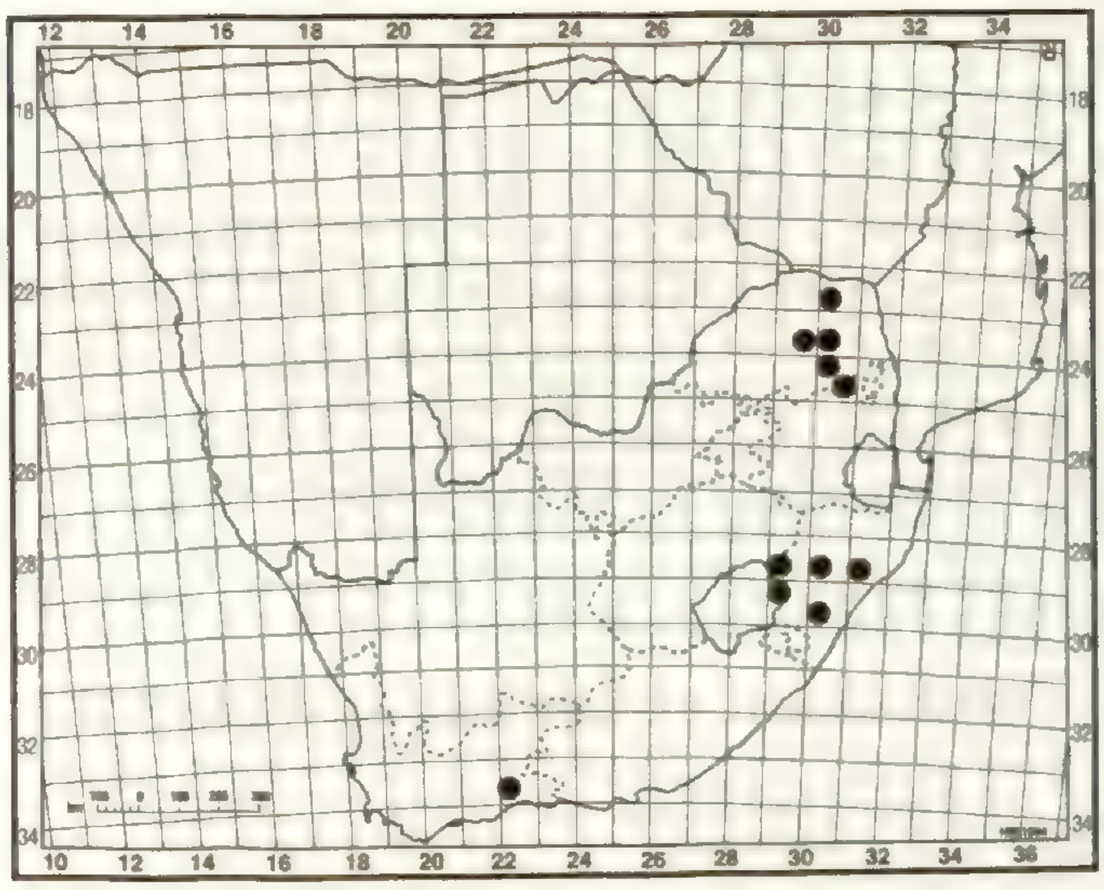
This species is identified by the relatively broad branch leaf with subacute to rounded-obtuse apex and mucronate costa, and the stem leaf with acute to obtuse apex and mucronate to short-excurrent costa.

2. **Schlotheimia percuspidata** *C. Müll.* in Hedwigia 38: 117 (1899); Broth. in Natürl. PflFam., edn 2, 11: 48 (1925); Sim, Bryo. S. Afr. 285 (1926); Van Rooy & Van Wyk in Bryologist 95: 212 (1992). Type: Cape, Blanco, Oct. 1875, *Rehmann s.n.*

Plants medium-sized to large, forming mats, olivaceous or yellowish green to green above, orange-brown or reddish brown to brown below; corticolous. *Primary stem* up to 70 mm long, branching regularly, tomentose; rhizoids smooth to weakly papillose, orange-brown to brown; secondary stem up to 38 mm tall, branching by subperichaetial innovations; in section inner cortex 5–8 cells across, incrassate, outer cortical cells smaller, in 2–4 rows consisting of stereids. *Stem leaves* crowded; ovate to ovate-lanceolate, 0.6–1.3 mm long; apex acute or acuminate; margins decurrent; costa ending below apex, extending into acumen or short-excurrent, awn up to 220 µm long. *Branch leaves* crowded, ± equal in size, appressed and twisted to spirally twisted around stem when dry, erect-spreading to widespreading when wet, rugose; oblong to oblong-lanceolate, 1.5–2.8 mm long; ventral surface keeled; apex acute, subacute or cuspidate; margins plane, occasionally reflexed on one side below, entire. *Costa* ending below apex or extending into cuspidate point; in section subround, lamina ventrally inserted, cells not differentiated or 2 ventral cells larger, consisting of stereids, dorsal surface smooth to rough. *Upper laminal cells* rounded-hexagonal to rounded, incrassate, ± flat, 8–13 µm, smooth; basal cells rhomboidal to rectangular, incrassate, strongly pitted.

Pseudautoicous; dwarf male plant axillary on secondary stem, branching by subperigonial innovations. *Perichaetia* terminal, frequently overgrown by subperichaetial innovations; leaves oblong-lanceolate or lanceolate, 2.3–3.0 mm long, apex acuminate or cuspidate, costa ending below apex to cuspidate. *Seta* 3–5 mm long, yellowish brown or red-brown. *Capsule* ovoid or oblong-cylindrical, red-brown to brown, smooth to weakly ribbed; urn 1.3–1.8 mm long; neck 0.2–0.5 mm long, wrinkled dry; exothecial cells irregular in shape, incrassate, smaller at mouth. *Peristome* double; exostome teeth 16, revolute dry, linear, consisting of 2 divisions, 400–470 µm long, brown, densely striolate-papillose; endostome segments 16–32, outer surface smooth, inner surface vertically striolate-papillose, yellowish. *Operculum* 1 mm long. *Calyptra* 3.0–3.5 mm long, yellowish brown or reddish brown. *Spores* 12–35 µm, granulate; anisosporous. Fig. 145: 15–22.

Schlotheimia percuspidata grows on bark of trees and on rock, and is infrequently collected in montane forests of the northern and eastern Transvaal regions, Zululand and KwaZulu-Natal. This African endemic is also known from Tanzania, Malawi and Zimbabwe. Map 204.



MAP 204.—**Schlotheimia percuspidata**

Vouchers: *Filter 26; Magill 5216, 5510; Smook 904; Van Rooy 1645; Von Breitenbach 172, 466.*

Schlotheimia percuspidata is most easily identified by the branch leaves that are gradually narrowed towards the cuspidate apices. The stem leaf costa usually ends below the acute to acuminate apex but sometimes also extends into the acumen or becomes short-excurrent.

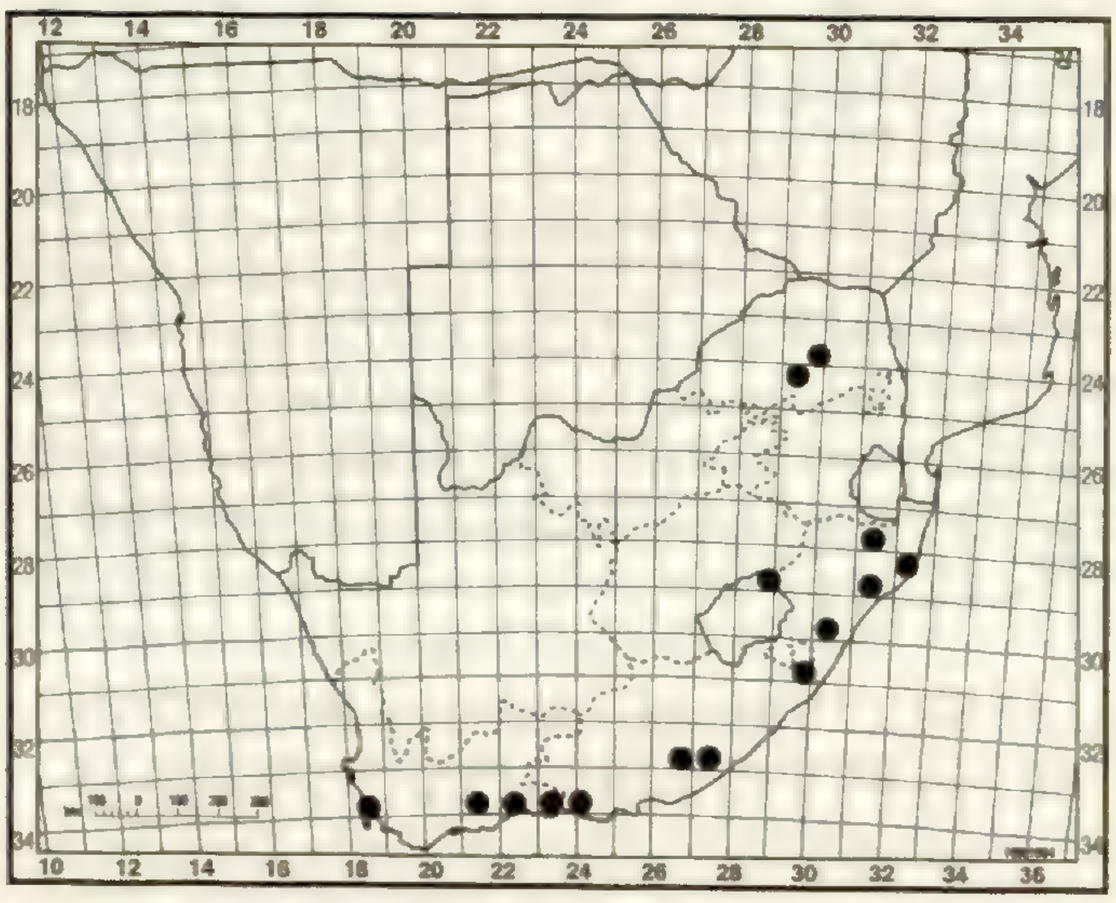
Several specimens from the eastern Transvaal region (*Brenan M3330; Crosby & Crosby 7646, 7648, 7658, 13398; Stirton 9813; Vorster 503*) differ in the acute to rounded-obtuse apices and mucronate costae of their branch leaves. These specimens can, however, be distinguished by the stem leaf costa which ends below the acuminate apex.

3. **Schlotheimia rufopallens** *C. Müll.* in Hedwigia 38: 117 (1899); Broth. in Natürl. PflFam., edn 2, 11: 48 (1925). Lectotype: Cape, Blanco, *Rehmann* 154 (BM!) *fide* Van Rooy & Van Wyk in Bryologist 95: 212 (1992).

Schlotheimia exrugulosa C. Müll. in Hedwigia 38: 118, (1899). Lectotype: Cape, Table Mountain, *Rehmann* 152 (BM!) *fide* Van Rooy & Van Wyk in Bryologist 95: 212 (1992).

Plants medium-sized, in mats, olivaceous above, orange-brown, reddish brown or brown below; corticolous. *Primary stem* to 70 mm long, branching regularly, frequently tomentose; rhizoids smooth to weakly papillose, orange or reddish brown; secondary stem to 30 mm tall, branching by subperigonial and subperichaetial innovations; in section inner cortex 5–9 cells across, incrassate, outer cortical cells smaller, in 1–3 rows, consisting of stereids, outer surface occasionally rough. *Stem leaves* generally crowded; ovate-lanceolate to lanceolate, 0.5–1.5(–1.8) mm long; apex acute to acuminate; margins slightly decurrent; costa aristate, awn (120–)180–400(–460) µm long. *Branch leaves* crowded, ± equal in size, appressed and twisted to spirally twisted around stem when dry, erect-spreading to squarrose when wet, rugose; oblong, (1.0–)1.3–2.5 mm long; ventral surface keeled; apex acute, subacute or rounded-obtuse; margins plane or reflexed on one side below, entire, weakly prorate or crenulate above. *Costa* mucronate to cuspidate; in section subround, lamina ventrally inserted, 2 ventral cells larger, consisting of stereids, dorsal surface prorate. *Upper laminal cells* rounded-hexagonal to rounded or oval, incrassate, ± flat, 5–12 µm, smooth; basal cells rhomboidal to rectangular, incrassate, strongly pitted, infrequently papillose.

Dioicous. *Perigonia* terminal, leaves ovate. *Perichaetia* terminal, frequently overgrown by subperichaetial innovations; leaves broadly oblong, oblong-lanceolate or lanceolate, 1.8–2.8 mm long. *Seta* 3–9 mm long, yellowish brown or reddish brown. *Capsule* oblong-cylindrical, yellowish brown, reddish brown or red brown, ribbed, urn 1.0–1.5 mm long, neck 0.5 mm long; exothecial cells irregular in shape, incrassate, smaller towards mouth, 2–4 rows at mouth transversely elongated. *Peristome* double; exostome teeth 16, revolute dry, linear, consisting of 2 divisions, 280–410 µm long, yellow-brown, densely striolate-papillose; endostome segments 16–32, outer surface smooth, inner surface vertically striate-papillose, yellowish or hyaline. *Operculum* 1 mm long. *Calyptra* 2.0–3.5 mm long, yellow-brown, reddish brown or brown. *Spores* 20–32 µm, granulate; isosporous. Fig. 145: 23–30.



MAP 205.—**Schlotheimia rufopallens**

Schlotheimia rufopallens is known only from scattered localities in the southwestern, southern and eastern Cape regions, KwaZulu-Natal, Zululand, and the central and northern Transvaal areas. Map 205.

Vouchers: *Cooper 17; Magill 5185, 5335; Schelpe 7871; Smook 1597, 1620; Von Breitenbach 344, 414.*

Schlotheimia rufopallens can be recognized by the aristate costae and acute to acuminate apices of its stem leaves. This species has narrower branch leaves and a longer excurrent stem leaf costa than *Schlotheimia ferruginea* and *S. percuspidata*. The dioicous sexual condition and isomorphic spores also help to identify plants.

Insufficiently known species

Schlotheimia rufoaeruginosa C. Müll. in Linnaea 39: 410 (1875); Broth. in Natürl. PflFam., edn 2, 11: 48 (1925); Sim, Bryo. S. Afr. 284 (1926). Type: 'Africa australis, Natal, Drakensberg, in Polypodii incani rhizomate: *M. Lea* 1874.' The type could not be located.

Schlotheimia rufoglauca C. Müll. in Hedwigia 38: 118 (1899); Broth. in Natürl. PflFam., edn 2, 11: 48 (1925). Type: 'Prom. bonae spei, Knysna district, in sylvis prope Esternek, Nov. 1875, . . . *Rehmann s.n.*' The type could not be located. Rehmann specimens in H! and PRE!, originally named as *S. rufoglauca* but collected near Portland (*Rehmann 153*), are *S. rufopallens*. Sim (1926) treated the species as a synonym of *S. rufoaeruginosa*.

Schlotheimia ventrosa C. Müll., Syn. musc. frond. 1: 756 (1849); Broth. in Natürl. PflFam., edn 2, 11: 47 (1925). Type: 'Prom. b. spei, Olifantshoek in Districtu Uitenhagen: *Ecklon.* Hb. Kunz.' The original material in Herb. Kunze (LZ) was probably destroyed and suitable type material could not be located. Sim (1926) noted that this species (from descriptions only) may be a synonym of *S. grevilleana* Mitt. Magill & Schelpe (1979) noted that *S. subventrosa* (treated here as a synonym of *S. ferruginea*) is conspecific with *S. ventrosa*. A specimen in BM named as *S. ventrosa* and collected at the type locality by Pappe is *S. ferruginea*.

9. CARDOTIELLA

Cardotiella *Vitt* in J. Hattori Bot. Lab. 49: 101 (1981); Van Rooy & Van Wyk in Bryologist 95: 212 (1992). Type species: *C. subappendiculata* (Broth.) Vitt.

Plants large, forming mats, green to yellowish green or yellowish brown above, brown below; saxicolous or corticolous. *Primary stems* creeping, tomentose; secondary stems erect-curved, widely spaced. *Leaves* crowded, secund, in 4 or 5 rows, generally rugose, frequently falcate, ovate to lanceolate; margins decurrent, irregularly denticulate above, denticulate to spinulose below; stem leaves smaller. *Laminal cells* rounded to rounded-hexagonal, homogeneous, papillose to strongly papillose, frequently obscure below; cells of decurrency irregularly rectangular, inflated, smooth, frequently tuberculate at margin.

Dioicous. *Perigonia* lateral, gemmate. *Perichaetia* terminal on secondary stems, leaves ovate-subulate to oblong-subulate. *Seta* short. *Capsule* exserted, elliptic, 8-ribbed; stomata phaneropore. *Peristome* double; exostome teeth 16, fused below; endostome segments 8–16, alternating with teeth. *Operculum* conic-rostrate. *Calyptra* mitrate, lobed at base, weakly plicate, hairy. *Spores* round, minutely papillose, pale brown.

Cardotiella is a genus of six species; four are endemic on the East African islands of Madagascar, Mauritius and Réunion, one species is known only from the Neotropics, and one is endemic to South Africa. The genus is characterized by the erect-curved branches with secund, rugose leaves; leaf decurrency of large, inflated and smooth cells; strongly unipapillose, homogeneous laminal cells; well-developed peristome, and the large mitrate calyptra.

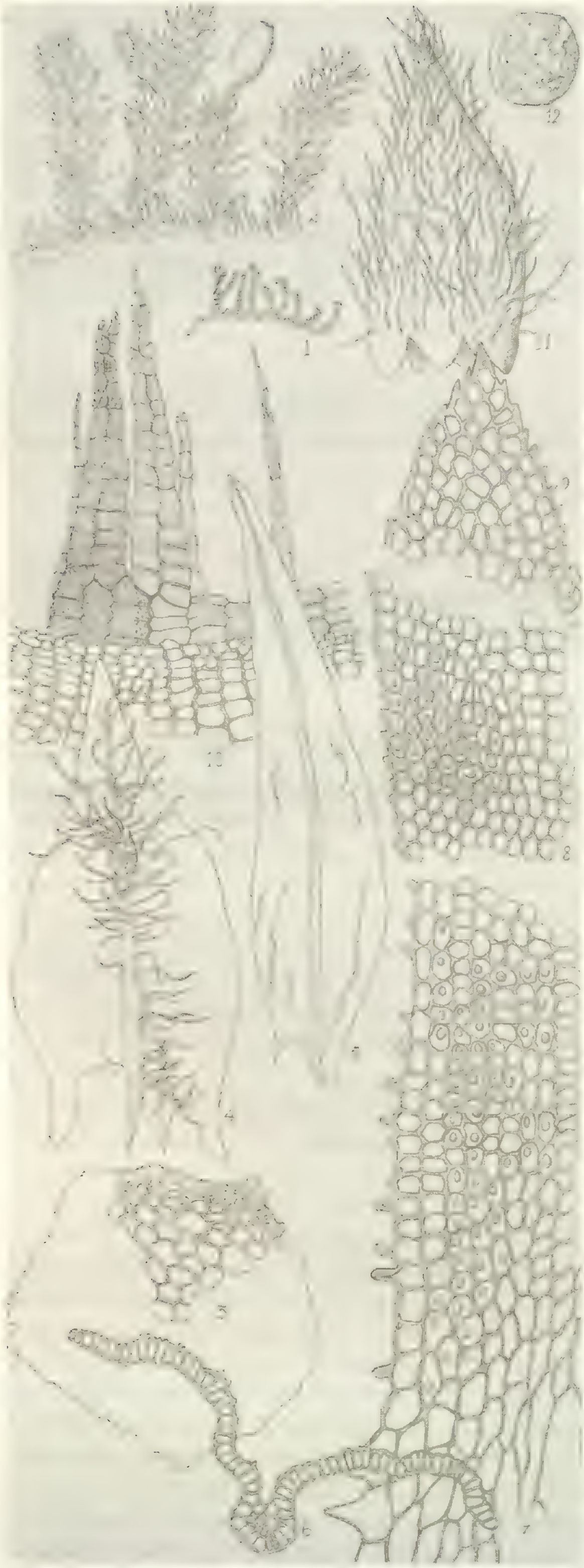
Cardotiella secunda *(C. Müll.) Vitt* in J. Hattori Bot. Lab. 49: 105 (1981); Van Rooy & Van Wyk in Bryologist 95: 212 (1992). Type: Cape, Olifantshoek District, Uitenhage, *Pappe s.n.*

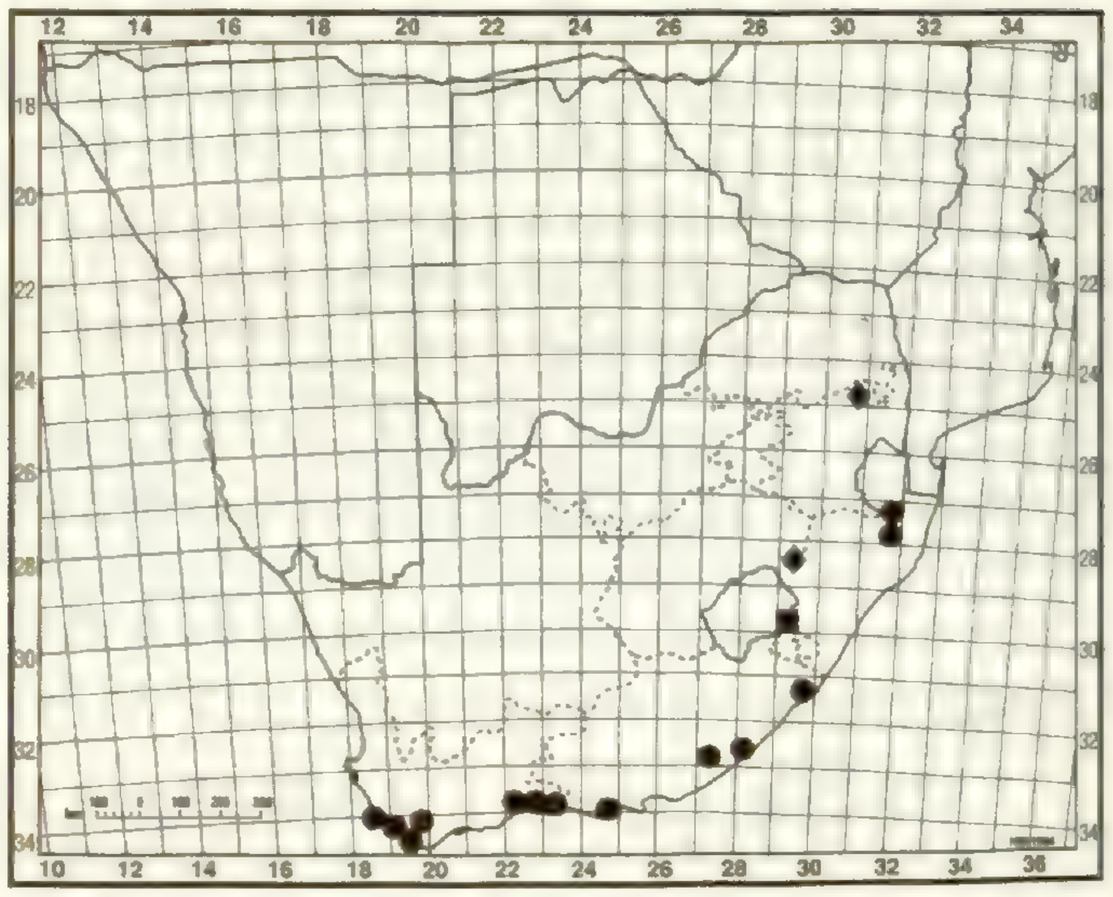
Macromitrium secundum C. Müll. in Bot. Zeitung (Berlin) 14: 420 (1856); Sim, Bryo. S. Afr. 281 (1926). *Coleochaetium secundum* (C. Müll.) Broth. in Natürl. PflFam. 1,3: 475 (1902).

Macromitrium schlotheimiaeformis Par., Ind. bryol. suppl. 1: 241 (1900). *Cardotiella schlotheimiaeformis* (Par.) Vitt in J. Hattori Bot. Lab. 49: 103 (1981). Lectotype: Cape, Cape Town, Devil's Peak, *Rehmann 151* (NY; PRE, isolectō.!).

Plants large, forming mats, green to yellowish green or yellowish brown above, brown below; saxicolous or corticolous. *Primary stem* creeping, up to 70 mm long, irregularly branched, frequently tomentose; rhizoids smooth, reddish brown; secondary stem erect-curved, branching by subperichaetial innovations, occasionally tomentose below; in section round, central strand absent, inner cortex 8–12 cells across, thin to thick-walled, outer cortical cells in 2–4 rows, walls incrassate or consisting of stereids, outer surface rough. *Stem leaves* weakly rugose to rugose, occasionally falcate, frequently reflexed; ovate, ovate-acuminate, ovate-ligulate or ovate-lanceolate to lanceolate, (0.8–)1.0–1.7(–2.0) mm long; apex acute to acuminate; margins plane, entire to irregularly denticulate above, denticulate to spinulose below, decurrent; costa ending below apex to subpercurrent or infrequently mucronate. *Branch leaves* crowded, ± equal in size, secund, in 4 or 5 rows, generally rugose, occasionally falcate; ovate-lanceolate or oblong-lanceolate to lanceolate to narrowly lanceolate, 1.0–2.5 mm long; apex acuminate, acute or rarely rounded-obtuse; margins plane, entire to irregularly denticulate above, denticulate to spinulose below, decurrent; cells of decurrency irregularly rectangular, inflated, smooth. frequently tuberculate at margin; unistratose. *Costa* ending below apex to subpercurrent or occasionally mucronate; ventral superficial cells rounded or short-rectangular above, linear below; dorsal superficial cells rounded to oval above, linear below; in cross section subround, flat ventrally, bulging dorsally, 2 ventral surface cells incrassate or substereids, central cells incrassate or consisting of stereids, dorsal surface cells incrassate or consisting of substereids. *Laminal cells* rounded-hexagonal or rounded-quadrate, homogeneous, incrassate, frequently obscure, 7–10 µm, smooth to papillose above, papillose to strongly papillose or spinulose below, papillae single, conical; basal marginal cells occasionally subquadrate, protruding.

Dioicous. *Perigonia* lateral, gemmate, leaves broadly ovate-apiculate. *Perichaetia* terminal on branches; leaves ovate-subulate to oblong-subulate, 2.3–3.2 mm long. *Seta* 1.0–1.8 mm long, yellowish brown or reddish brown. *Capsule* elliptic; urn 1.2–1.8 mm long; neck 0.6–1.0 mm long; yellowish brown or reddish brown to brown, 8-ribbed; exothecial cells irregular rectangular to quadrate, smaller at mouth, incrassate; stomata present at base of urn and on neck; annulus weakly differentiated. *Peristome* recurved when dry; exostome teeth 16, fused below to form 8 pairs, perforated above, 0.4 mm long, yellow-brown, papillose below, vertically striolate-papillose above;





MAP 206.— ● **Cardotiella secunda**
♦ **Rhabdoweisia fugax**
■ **Rhabdoweisia crispata**

endostome segments 8–16, alternating with teeth, shorter than exostome, narrow, hyaline, outer surface smooth, inner surface vertically striolate. *Operculum* 0.8–1.0 mm long. *Calyptra* 2.2–2.5 mm long, yellow or yellowish brown. *Spores* 15–23 µm. Fig. 146.

Endemic to southern Africa, *Cardotiella secunda* is known from scattered localities in forests of the southwestern, southern and eastern Cape, and Zululand. Map 206.

Vouchers: *Magill 5476, 6047, 6269, 6307, 7640; Schelpe 7646; Van Rooy 944, 1714a; Van Zinderen Bakker 249.*

The erect-curved branches, secund, rugose leaves with decurrent margins, strongly papillose laminal cells and peristome characters separate *C. secunda* from other members of the subfamily.

FIG. 146.—**Cardotiella secunda**: **1.** habit (dry), × 1; **2.** habit (wet), × 5; **3.** branch in cross section (cells partly shown), × 175; **4.** stem leaf, × 35; **5.** branch leaf, × 35; **6.** branch leaf in cross section, × 175; **7.** basal cells of branch leaf at left margin, × 350; **8.** upper laminal cells of branch leaf (left side), × 350; **9.** branch leaf apex, × 350; **10.** part of capsule mouth with peristome (papillae partly shown), × 140; **11.** calyptra, × 18; **12.** spore, × 700. (1, 3, 5 & 11, *Schelpe 7640*; 2, 10 & 12, *Magill 6269*; 4 & 6, *Crosby 6269*; 7, *Taylor 6312*; 8, *Van Zinderen Bakker 249*; 9, *Magill 5476*.)

RHABDOWEISIACEAE

Plants small, caespitose; terricolous. *Stems* erect; in section round, central strand absent; rhizoids smooth. *Leaves* crisped when dry, erect to erect-spreading when wet; linear-lanceolate, narrowly oblong-lanceolate or narrowly ligulate; margins plane or recurved on one side below, entire, crenulate or irregularly denticulate. *Costa* ending below apex, in section with median guide cells. *Upper laminal cells* rounded-quadrate or rounded-hexagonal, incrassate, smooth; basal cells rectangular, thin-walled, frequently hyaline.

Autoicous. *Perichaetia* terminal, leaves scarcely differentiated. *Capsule* exserted, erect, 8-ribbed; stomata phaneropore; annulus absent. *Peristome* single, frequently fugacious, teeth 16, distant, narrow, smooth, basal membrane low. *Operculum* conic-rostrate, oblique. *Calyptra* cucullate, smooth, naked. *Spores* subtriangular-globular; granulate, brownish.

Anderson & Crum (1959) proposed the family to contain the genera *Rhabdoweisia* B.S.G., *Rhabdoweisiella* Williams and *Amphidium* Schimp. *Amphidium* is closely related to some of the diplolepidous genera in the Orthotrichaceae (Lewinsky 1976) and is treated there for the *Flora* (see p. 486). However, the haplolepidous origin of the peristome in the Rhabdoweisiaceae indicates a position in the Dicranales rather than the Orthotrichales.

RHABDOWEISIA

Rhabdoweisia *B.S.G.*, Bryol. eur. 1: 97 (1846); Broth. in Natürl. PflFam., edn 2, 10: 194 (1924); Sim, Bryo. S. Afr. 151 (1926); Lawton in Bryologist 64: 141 (1961); Smith, Moss Fl. Brit. Irel. 128 (1978); Crum & Anderson, Moss. E.N. Amer. 1: 176 (1981); Van Rooy in Bryologist 94: 409 (1991). Type species: *R. fugax* (Hedw.) B.S.G.

The genus contains approximately five species and occurs in Europe, Greenland, North and South America, Asia and Africa. *Rhabdoweisia* is represented in Africa by four species of which two occur in southern Africa.

Leaf margins entire to crenulate, apex generally acuminate, laminal cells in (4)5–7(8) rows on each side of costa at leaf middle; spores 11–17 µm . . . . . 1. *R. fugax*
Leaf margins irregularly denticulate, apex generally acute, laminal cells in (5–)7–9(10) rows on each side of costa at leaf middle; spores 16–25 µm . . . . . 2. *R. crispata*

1. **Rhabdoweisia fugax** *(Hedw.) B.S.G.*, Bryol. eur. 1: 98 (1846); Broth. in Natürl. PflFam. 1,3: 313 (1909); Sim, Bryo. S. Afr. 151 (1926); Nyholm, Moss Fl. Fenn. 49 (1954); Smith, Moss Fl. Brit. Irel. 128 (1978); Van Rooy in Bryologist 94: 409 (1991). Type: Germany; Sudeten, *Breutel*, Musci frondosi 260 (NY, neo.), *vide* Lawton in Bryologist 64: 144 (1961).

Weissia fugax Hedw., Sp. musc. frond. 64 (1801).

Plants yellowish green to brown; terricolous. *Stems* up to 5 mm tall, branching by subperichaetial innovations; rhizoids reddish brown, smooth; in section with cortical cells thin-walled, epidermis not differentiated. *Leaves* larger above, crisped when dry, erect to erect-spreading when wet, reflexed; linear-lanceolate, 1.0–1.8 mm long; keeled; apex acuminate or occasionally acute; base scarcely differentiated, ± sheathing in upper leaves; margins plane or frequently recurved on one side below, entire to crenulate at apex, frequently flexuose above. *Costa* ending below apex to subpercurrent, ventral superficial cells rectangular, dorsal superficial cells linear; in section crescent-shaped to subround, ventral surface flat, lamina ventrally inserted, guide cells in 1 layer, ventral stereid band absent, ventral surface cells incrassate,

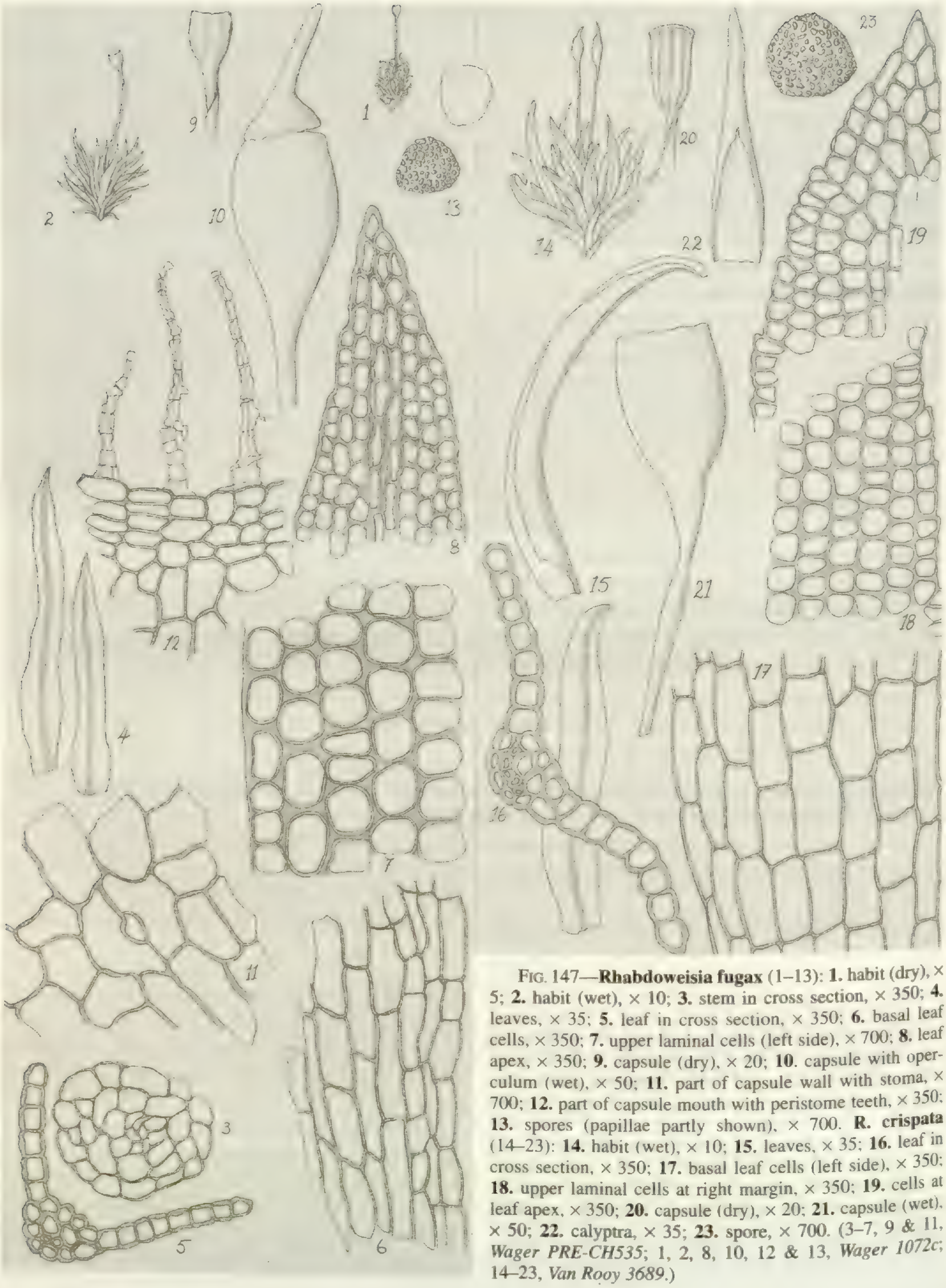


FIG. 147—**Rhabdoweisia fugax** (1–13): **1.** habit (dry), × 5; **2.** habit (wet), × 10; **3.** stem in cross section, × 350; **4.** leaves, × 35; **5.** leaf in cross section, × 350; **6.** basal leaf cells, × 350; **7.** upper laminal cells (left side), × 700; **8.** leaf apex, × 350; **9.** capsule (dry), × 20; **10.** capsule with operculum (wet), × 50; **11.** part of capsule wall with stoma, × 700; **12.** part of capsule mouth with peristome teeth, × 350; **13.** spores (papillae partly shown), × 700. **R. crispata** (14–23): **14.** habit (wet), × 10; **15.** leaves, × 35; **16.** leaf in cross section, × 350; **17.** basal leaf cells (left side), × 350; **18.** upper laminal cells at right margin, × 350; **19.** cells at leaf apex, × 350; **20.** capsule (dry), × 20; **21.** capsule (wet), × 50; **22.** calyptra, × 35; **23.** spore, × 700. (3–7, 9 & 11, *Wager PRE-CH535*; 1, 2, 8, 10, 12 & 13, *Wager 1072c*; 14–23, *Van Rooy 3689*.)

bulging, dorsal stereid band small, dorsal surface cells incrassate, bulging. *Upper laminal cells* rounded-quadrate or rounded-hexagonal, incrassate, bulging, 8.7–16.3 µm, smooth, in (4)5–7(8) rows on each side of costa at leaf middle, in 3–5(6) rows just below apex; basal cells occasionally reaching higher along costa, rectangular, thin-walled, smooth.

Autoicous. *Perigonia* terminal on short branches, inner leaves ovate. *Perichaetia* terminal, leaves scarcely differentiated. *Seta* 1.8–2.4 mm long, yellowish to brown, twisted anticlockwise above. *Capsule* exserted, ovoid, 0.7 mm long, yellowish to brownish, weakly 8-ribbed, neck short, mouth orange; exothecial cells irregular rectangular, thin-walled, smaller above, 2–4 rows at mouth transversely elongated, cells of ribs weakly differentiated, bulging; stomata on neck, few, phaneropore. *Peristome* single, inserted below mouth, teeth 16, distant, filiform, 93–110 µm long, orange, smooth, basal membrane low. *Operculum* 0.5 mm long. *Calyptra* not seen. *Spores* 11–15 µm. Fig. 147: 1–13.

The species is known from Europe, the Caucasus, eastern Siberia, Macaronesia, Sri Lanka, China, the Neotropics, and southern Africa. In the *Flora* area the species is known from the Drakensberg of KwaZulu-Natal and the eastern Transvaal region. Map 206.

Vouchers: *MacLea sub Rehmann 501; Wager PRE-CH11570.*

Rhabdoweisia fugax is recognized by its linear-lanceolate leaves with acuminate apices, entire to crenulate leaf margins, and the single peristome with distant, filiform teeth abruptly narrowed from a low basal membrane.

2. **Rhabdoweisia crispata** *(Dicks.) Lindb.* in Act. Soc. Sci. Fenn. 10: 22 (1871); Smith, Moss Fl. Brit. Irel. 130 (1978); Crum & Anderson, Moss. E.N. Amer. 1: 177 (1981). Type: Herb. Dickson, sheet 32 no. 30 (BM, lecto.!) *fide* Van Rooy in Bryologist 94: 409 (1991).

Bryum crispatum Dicks., Pl. crypt. brit. 4: 29 (1801).

Plants green above, light brown below; terricolous. *Stems* up to 5 mm tall, branching by subperichaetial innovations, tomentose below; rhizoids reddish brown, smooth; in section with cortical cells thin-walled, outer 1 or 2 rows smaller, epidermis not differentiated. *Leaves* larger above, crisped when dry, erect to erect-spreading when wet, recurved; narrowly oblong-lanceolate, narrowly ligulate or linear-lanceolate, 1.0–2.3(–3.2) mm long; keeled; apex acute or occasionally acuminate; base scarcely differentiated, ± sheathing; margins plane or frequently recurved on one side below, irregularly denticulate or serrulate, flexuose above. *Costa* ending below apex, ventral superficial cells rectangular, dorsal superficial cells linear; in section crescent-shaped, ventrally flat, lamina ventrally inserted, guide cells in 1 layer, ventral stereid band absent, ventral surface cells incrassate, dorsal stereid band small, dorsal surface cells incrassate or substereids, bulging. *Upper laminal cells* irregularly rounded-quadrate or rounded-hexagonal, incrassate, bulging, 11.2–17.5(–20.0) µm, smooth, in (5–)7–9(10) rows on each side of costa at leaf middle, in (4)5 or 6(7) rows just below apex; basal cells rectangular, thin-walled.

Autoicous. *Perigonia* terminal on short branches below perichaetia, inner leaves ovate. *Perichaetia* terminal, leaves scarcely differentiated. *Seta* 1.6–2.7 mm long, yellowish brown, twisted anticlockwise above. *Capsule* exserted, ovoid, 0.4–0.8 mm long, yellowish brown to brown, weakly 8-ribbed, neck short; exothecial cells irregular-rectangular, smaller at mouth, cells of ribs weakly differentiated; stomata few, on neck, phaneropore. *Peristome* single, inserted below mouth, fugacious, teeth not seen, basal membrane low, orange. *Operculum* 0.5–0.7 mm long. *Calyptra* 0.8–1.2 mm long, smooth, naked. *Spores* 16.0–22.5(–25.0) µm. Fig. 147: 14–23.

Rhabdoweisia crispata is rather widespread in the temperate to arctic northern hemisphere and has also been reported from Hawaii, the Neotropics, Juan Fernández islands, Lebanon, Bhutan, Java, and North and South Africa. The species has been collected recently (1987) on

the Drakensberg escarpment at Sani Pass. Map 206.

Voucher: *Van Rooy 3689*.

This species is most easily separated from *Rhabdoweisia fugax* by the shape of the peristome teeth. The filiform teeth of *R. fugax* abruptly narrow from the basal membrane while the narrowly lanceolate teeth of *R. crispata* taper evenly from the broad base. The only collection of *R. crispata* known from southern Africa, however, has immature capsules and capsules with the teeth broken away.

The two species are more difficult to separate in the absence of peristome teeth, but the broader leaves with acute apices and irregularly denticulate margins, and the larger spores will usually distinguish *R. crispata* from *R. fugax*.

RACOPILACEAE

A small family containing only two genera, Racopilaceae is primarily of southern hemisphere distribution. The genera, including *Racopilum*, the only representative in southern Africa, are recognized by their strongly dimorphic and ranked leaves which are tightly curled up and over the stem when dry.

RACOPILUM

Racopilum *P. Beauv.*, Prodr. Aethéogam. 36 (1805); Sim, Bryo. S. Afr. 447 (1926); Broth. in Natürl. PflFam., edn 2, 11: 52 (1926); Catcheside, Moss. S. Austr. 291 (1980). Type species: *R. mnioides* P. Beauv.

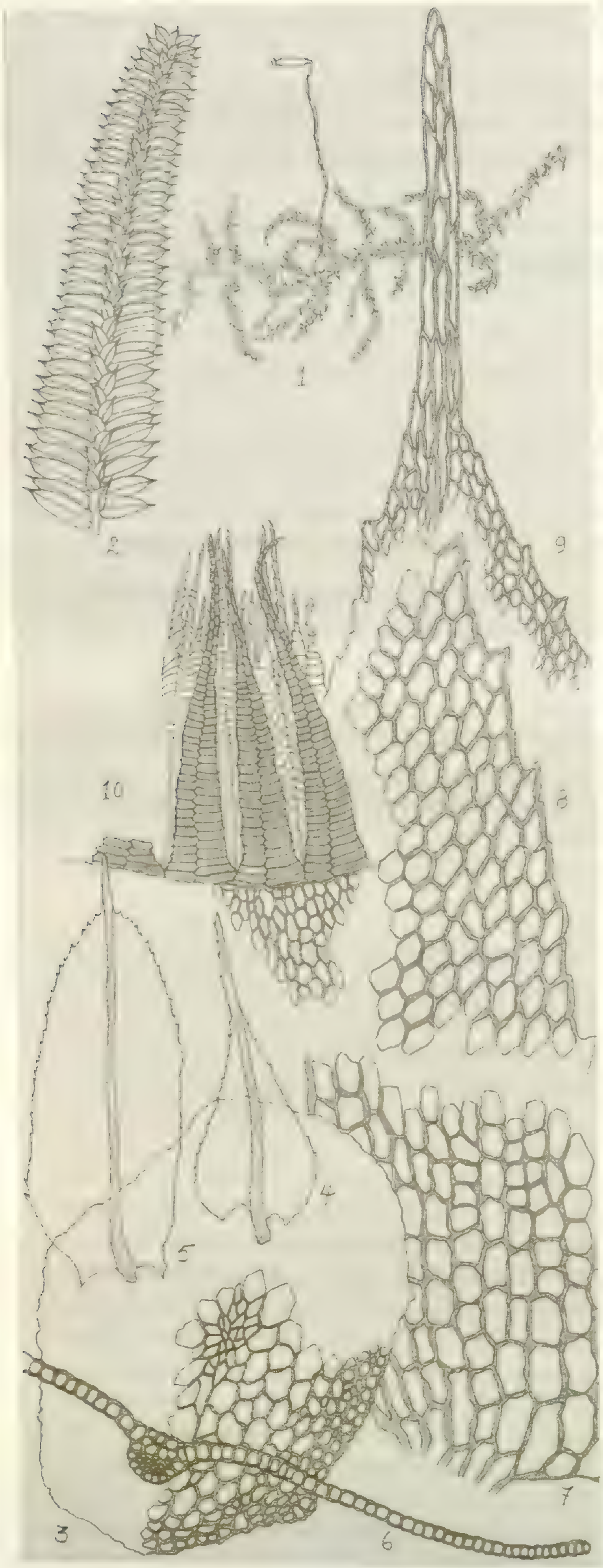
Plants small to large, in loose mats, dark green; mostly terricolous. *Stems* creeping, heterophyllous; central strand small. *Leaves* 4-ranked, incurved dry, widely spreading wet, leaves in lateral ranks larger than dorsal ranks; strongly cuspidate; margins weakly serrate above. *Leaf cells* rectangular to quadrate, minutely mammillose, rectangular below; alar cells not differentiated.

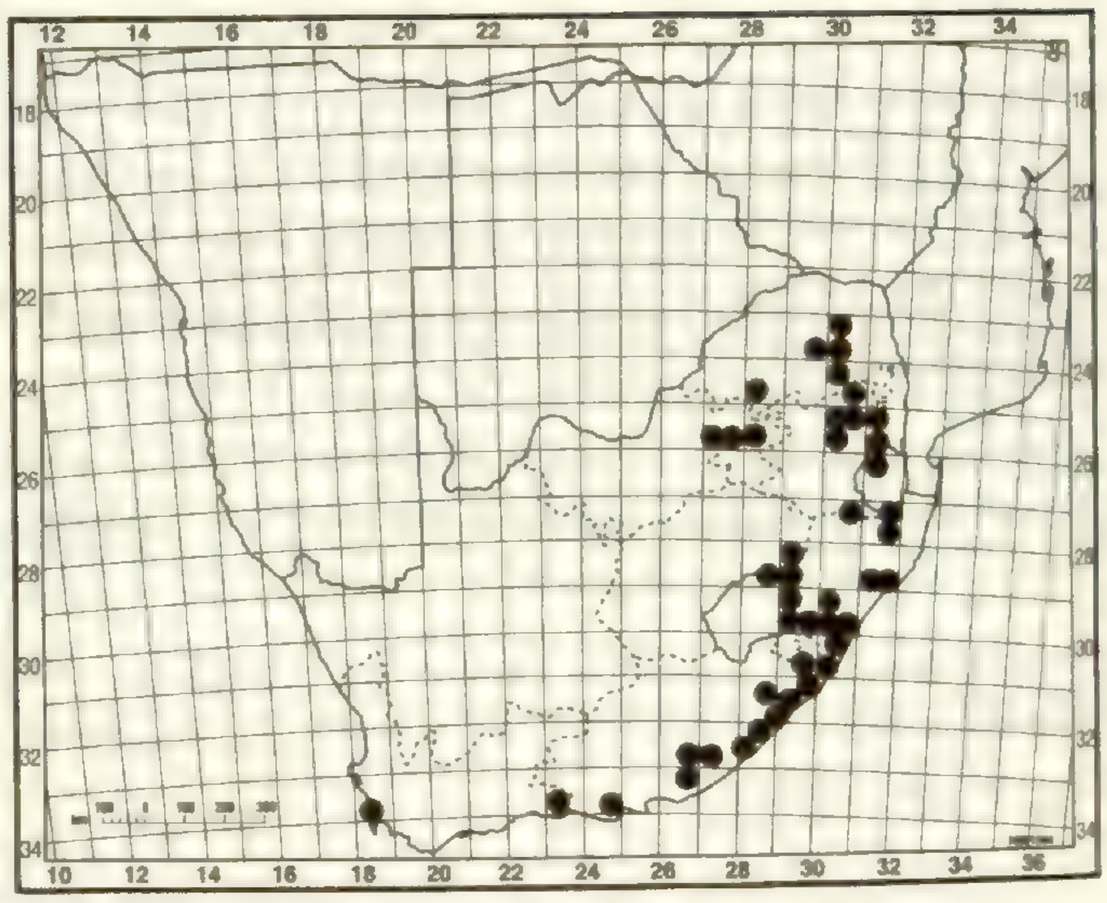
Dioicous or autoicous. *Perigonia* and perichaetia along stem. *Seta* long, smooth. *Capsule* horizontal, ribbed. *Peristome* double, complete. *Operculum* rostrate. *Calyptra* cucullate, somewhat hairy. *Spores* small, green.

A genus with over 60 species, found in the Americas, Africa, Madagascar, India, southern Asia, Australia, New Zealand and Oceania. The genus is easily identified by its dimorphous leaves which spread widely when wet. The leaves are arranged in four rows. The two apparently lateral rows of leaves are larger and broader than the two rows on the dorsal stem surface. Some species are described as having dwarf male plants on the rhizoids of the larger female plants. However, the southern African species has male and female plants of equal size; the males produce large perigonia between the lateral leaves.

Racopilum capense *C. Müll.* in Hedwigia 38: 124 (1899); Sim, Bryo. S. Afr. 447 (1926); Broth. in Natürl. PflFam., edn 2, 11: 53 (1925). Syntypes: Cape, Claremont, *Rehmann*, Oct. 1876; Touws River, *Rehmann*, Nov. 1875; Somerset East, Boschberg, *MacOwan s.n.* (G!); Natal, Inanda, *Rehmann 297* (PRE!); Van Reenen Pass, *Rehmann 297b* (PRE!).

Plants small to large, forming mats, dark green; terricolous, humicolous, saxicolous or corticolous. *Stems* creeping, up to 60 mm long, branching regular, pinnate; in section oval, central strand small, inner cortical cells thin-walled, hyaline, in 5 or 6 rows, outer cortical cells thick-walled, red-brown, in 2 or 3 rows; paraphyllia and pseudoparaphyllia absent. *Leaves* evenly spaced, 4-ranked, widespreading wet, incurved dry; lateral leaves broadly ovate to elliptical, 1–2 mm long; acute, cuspidate or short-awned; rounded at base; margins plane, entire below, serrate above; dorsal leaves ovate, 0.8–1.5 mm long; acute, cuspidate or short-awned; rounded at base; margins plane, weakly serrate. *Costa* single, short-excurrent, smooth, yellow, both surfaces smooth; in section bulging dorsally, guide cells thin-walled, ventral stereid band absent, ventral surface cells large, thick-walled, dorsal stereid band 2 cells thick, dorsal surface cells small, thick-walled. *Upper laminal cells* hexagonal to rhomboidal, becoming rectangular at margins in lateral leaves, rhombic to quadrate in dorsal leaves, 7–12 µm long, walls weakly thickened, ± homogeneous, minutely mammillose on both surfaces; basal cells quadrate to short-rectangular, 12–24 µm long, 12 µm wide, hyaline, walls smooth, weakly thickened; alar cells not differentiated.





MAP 207.—**Racopilum capense**

Dioicous. *Perigonia* axillary on stem, gemmate; perigonial leaves orbicular-acuminate. *Perichaetia* strongly differentiated; perichaetial leaves oblong to ovate, apex long-cuspidate, 1–2 mm long with awn 1–2 mm long, leaf cells fusiform, thin-walled and pitted. *Seta* 15–22 mm long, red-brown, smooth. *Capsule* exserted, horizontal to nodding, cylindrical to weakly pyriform, 2.5–3.0 mm long, ribbed, red-yellow, urn cylindrical, neck not differentiated; exothecial cells rectangular, walls firm, cells at mouth quadrate; annulus differentiated; stomata phaneropore on lower urn. *Peristome* complete, orange; exostome teeth linear from a broader base, erect with inflexed tips dry, incurved wet; striate below with median zigzag line, papillose above, up to 700 µm high; endostome segments keeled and perforated, as long as teeth, on high basal membrane, granulate; cilia 3, linear, as long as segments, granulate. *Operculum* conical and long-rostrate, 1.5 mm long. *Calyptra*

FIG. 148.—**Racopilum capense**: **1.** habit (dry), × 1; **2.** dorsal view of branch, × 5; **3.** stem in cross section (cells partly shown), × 175; **4.** dorsal leaf, × 32; **5.** lateral leaf, × 32; **6.** lateral leaf in cross section, × 175; **7.** basal cells of lateral leaf, × 350; **8.** upper laminal cells of lateral leaf (right side), × 350; **9.** lateral leaf apex, × 175; **10.** part of capsule mouth with peristome, × 70. (1, 4 & 5, *Crosby 7886*; 2, *Crosby 9141*; 3 & 6–10, *Crosby 7519*.)

not seen. *Spores* rounded, 12–16 µm, granulate, green. Fig. 148.

In the *Flora* area, *R. capense* is found in forest and woodland sites, especially near streams, in the northern, eastern and central Transvaal regions, Swaziland, KwaZulu-Natal, Zululand, and the eastern, southern and southwestern Cape areas. It is also found throughout western, southeastern and eastern Africa, the East African islands and the Arabian peninsula. Map 207.

Vouchers: *Crosby & Crosby 9141; Magill 3487, 4783; Oliver 7167A; Van Rooy 258.*

The single southern African species is easily identified by its dark green, creeping stems with dimorphic leaves. *Racopilum capense* is dioicous, with male plants as large as the female plants (*Kemp 1474*). Its nearest relatives are either monoicous, *R. tomentosum* (Hedw.) Brid., or produce dwarf males on rhizoids of female plants, *R. cuspidigerum* (Schwaegr.) Ångstr.

FONTINALACEAE

A family of four genera found primarily in temperate regions, especially in the northern hemisphere. In the *Flora* area, Fontinalaceae is represented by two species, *Fontinalis antipyretica* and *F. squamosa*. The plants, found in streams of the southwestern Cape, are believed to have been introduced with fish from Europe where both species are known to occur.

FONTINALIS

Fontinalis *Hedw.*, Sp. musc. frond. 298 (1801); Broth. in Natürl. PflFam., edn 2, 11: 57 (1925); Sim, Bryo. S. Afr. 354 (1926); Welch, Monograph Fontinalaceae 18 (1960). Lectotype species: *F. antipyretica* Hedw. cf. Myrin in Kongl. Vetensk. Acad. Handl. 1832: 273 (1832).

Plants long, in loose floating mats, dark green; aquatic and saxicolous. *Stems* elongated and branched; central strand absent; paraphyllia absent; pseudoparaphyllia absent. *Leaves* erect to spreading, frequently carinate or concave; margins plane, entire. *Costa* present as bistratose region in extreme leaf base. *Laminal cells* elongate, fusiform, thin-walled; alar cells strongly differentiated, enlarged, quadrate.

Dioicous. *Sporophytes* not known from the *Flora* area but described as: *Capsule* immersed to emergent, oval to cylindrical. *Peristome* double. *Operculum* long-conical. *Spores* medium-sized.

A genus of over 37 species found mostly in temperate regions of the northern hemisphere. The plants generally grow submerged on rock in streams or pools, but are also found exposed when water levels drop for short periods. The large mats fan out in still water and can cover extensive areas when conditions are right. The unistratose leaves and lack of vascular tissue separate specimens from aquatic vascular plants. *Fontinalis* can be confused with *Wardia*, another aquatic moss that grows in the mountains of the southwestern Cape. A comparison of the two indicates that *Fontinalis* has much longer stems which branch throughout, longer and narrower leaves which are frequently keeled and an immersed to emergent capsule.

Stem leaves keeled or deeply channelled when wet (most obvious at stem or branch tips) . . . . . 1. *F. antipyretica* var. *gracilis*
Stem leaves concave when wet, not keeled . . . . . 2. *F. squamosa*

1. **Fontinalis antipyretica** *Hedw.* var. **gracilis** *(Lindb.) Schimp.*, Syn. musc. eur. 2: 552 (1876); Welch, Monograph Fontinalaceae 46 (1960); Smith, Moss Fl. Brit. Irel. 495 (1980). Type: Finland, *Lindberg, 1868, fide* Welch (1960).

Fontinalis gracilis Lindb. in Hedwigia 6: 39 (1867); Broth. in Natürl. PflFam., edn 2, 11: 58 (1925).

Fontinalis antipyretica sensu Sim, Bryo. S. Afr. 354 (1926).

Plants long and slender, in floating mats, dark green to yellow green; aquatic and saxicolous. *Stems* up to 300 mm long, branches numerous, regular; in section round, central strand absent, inner cortical cells thin-walled, hyaline, becoming more thick-walled and yellowish towards margin, in 6–8 rows, outer cortical cells thick-walled, red, in single row; axillary hairs with basal cells brown, 6 or 7 cells long, hyaline. *Leaves* somewhat distant, spreading and keeled wet, appressed or spreading dry; 3.5–5.0 mm long, 1.8–2.2 mm wide; acute and frequently somewhat cucullate, weakly reflexed at tip; narrowed to insertion; margins plane, entire. *Costa* restricted to a bistratose region at insertion. *Upper laminal cells* linear, ± fusiform and sigmoid, homogeneous, smooth, 80–190 µm long, 10–12 µm wide, walls thin; basal cells not differentiated, yellowish, walls thin, smooth; alar

cells strongly differentiated, forming distinct groups, large, quadrate, hyaline, walls thin.

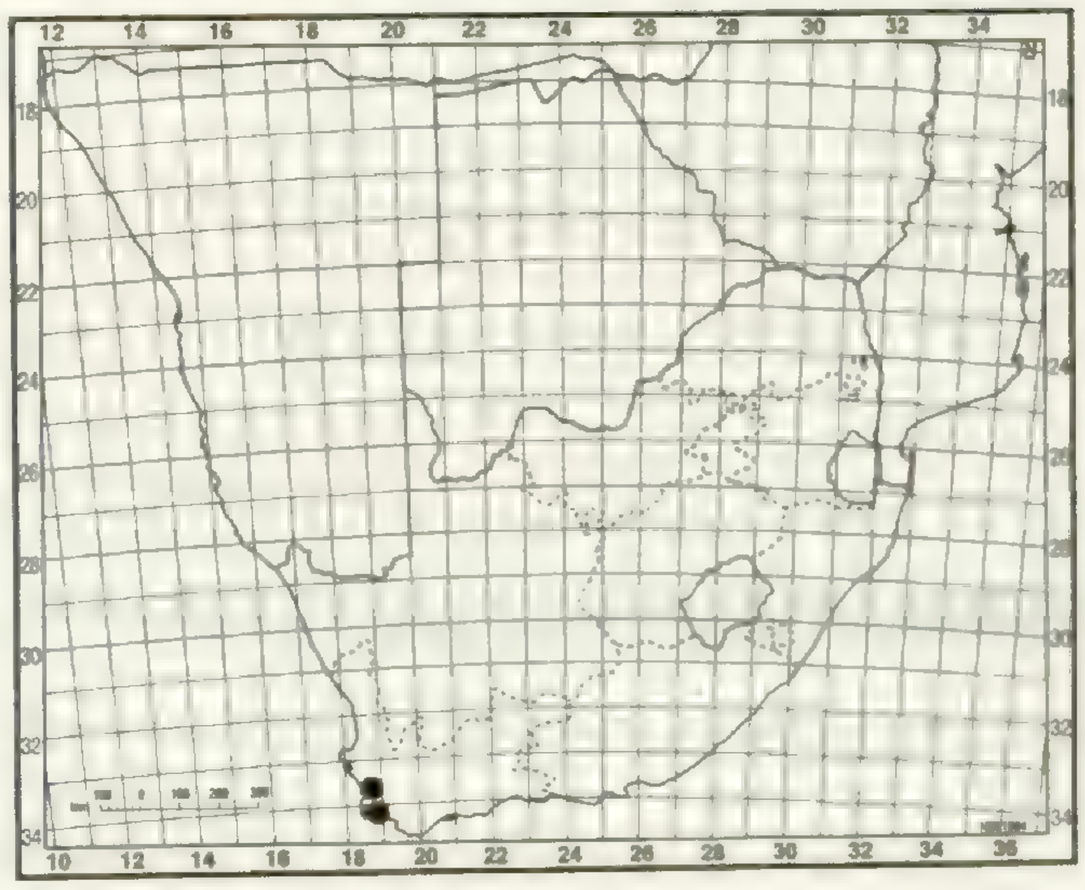
Sporophytes not known from the *Flora* area. Fig. 149: 7–11.

Widely distributed with numerous local subspecific taxa, *F. antipyretica* is found on rock and wood in cold water streams and ponds throughout the northern hemisphere, including North America, Europe and Asia. The variety *gracilis* was introduced into streams of the southwestern Cape and according to Sim (1926), was first collected in 1919. Map 208.

Vouchers: *Mogg 2837; Oliver 9052b; Pillans 9979; Wicht 11118.*

This variety is believed to have been introduced with fish from the northern hemisphere. The specimens clearly exhibit the characters of the European variety, *F. antipyretica* var. *gracilis*. In a group that is thought to express a great deal of environmental adaptation, this population, which has remained uniform for ± 80 years, should provide interesting insights into environmentally induced character modification.

The South African specimens are uniform and exhibit several interesting characters. For example, the leaves are flattened when dry and show a keel only when wet. Leaves are frequently split along the keel, especially on slides, thus masking the carinate condition. This may cause some confusion with the other species, *F. squamosa*, which has concave leaves. In *F. antipyretica* var. *gracilis* the leaves at the stem tips are distinctly keeled when wet, giving the stem an angled appearance. The leaves also appear ecostate, but have a bistratose area at the base which represents a rudimentary costa as described by Allen (1983).



MAP 208.—**Fontinalis antipyretica** var. **gracilis**

2. **Fontinalis squamosa** *Hedw.*, Sp. musc. frond. 299 (1801); Broth. in Natürl. PflFam., edn 2, 11: 60 (1925); Welch, Monograph Fontinalaceae 99 (1960). Type: England.

Plants long and slender, forming floating mats, green to dark green; aquatic and saxicolous. *Stems* up to 400 mm long, branching irregular, somewhat fasciculate; in section round to oval, central strand absent, inner cortical cells thin-walled, large, hyaline, outer cortical cells thick-walled and yellow, becoming smaller and reddish toward margin; axillary hairs with brown basal cells. *Leaves* evenly spaced, spreading wet, appressed dry, concave; stem leaves ovate-lanceolate, 3.5–4.5 mm long; acute to obtuse, weakly decurrent at base; margins plane to weakly inflexed, entire, weakly bordered, marginal cells not differing in shape but with a faint yellowish colour; branch leaves similar to stem leaves although somewhat smaller, 3.0–4.0 mm long. *Costa* absent or a few bistratose areas at extreme base of leaves. *Upper laminal cells* linear, somewhat fusiform, homogeneous, 110–125 µm long, 8–10 µm wide, walls thin, smooth; basal cells rectangular, forming distinct group at insertion, reddish brownish, smooth; alar cells strongly differentiated, enlarged and inflated, reddish, walls thin.

Sporophyte not known from *Flora* area. Fig. 149: 1–6.

Found on rocks in streams in Europe, Asia and northern and southern Africa, the species was probably also introduced with fish imported from Europe. At this time, the only collection is from below the main dam on the Eerste

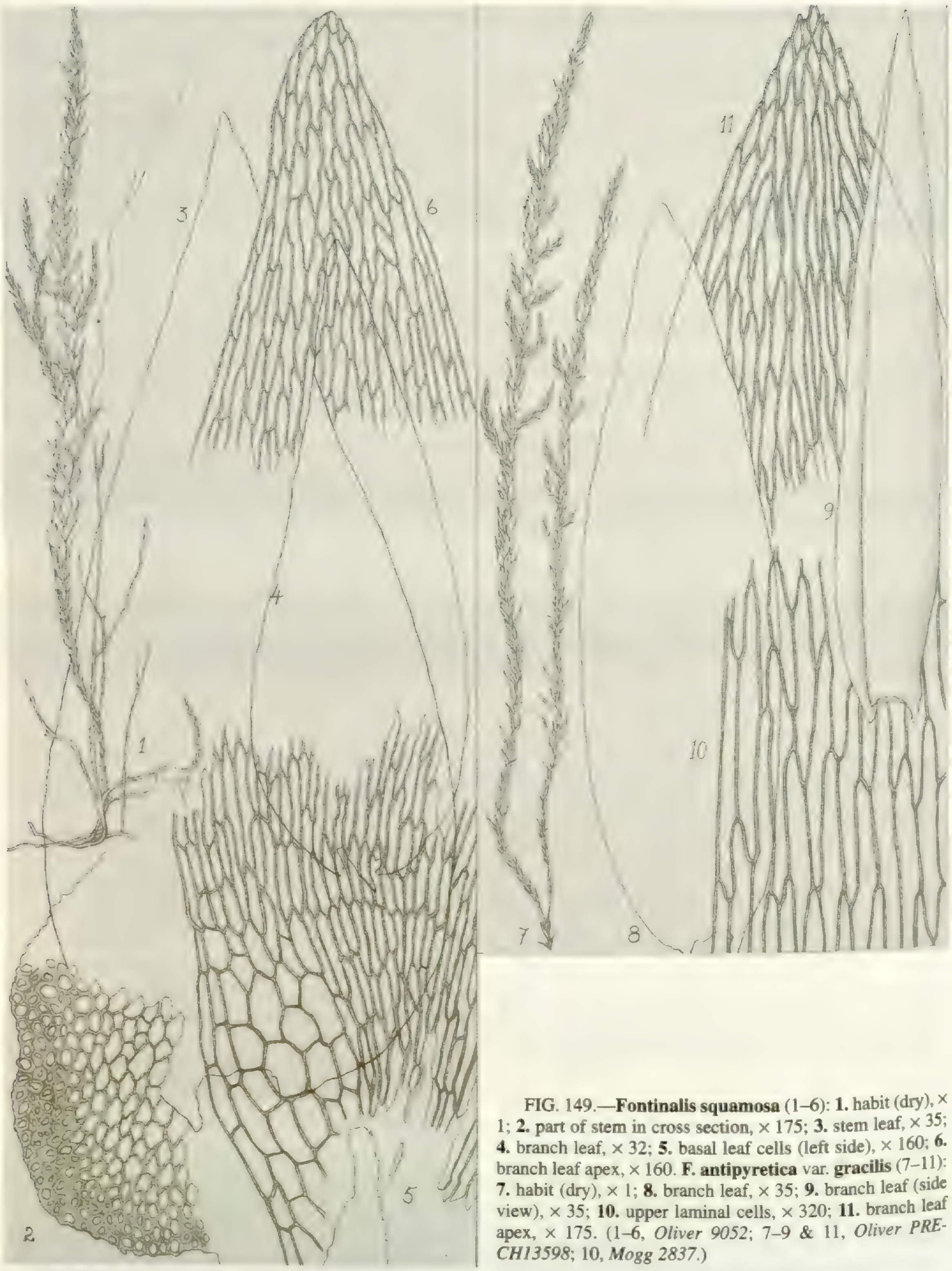
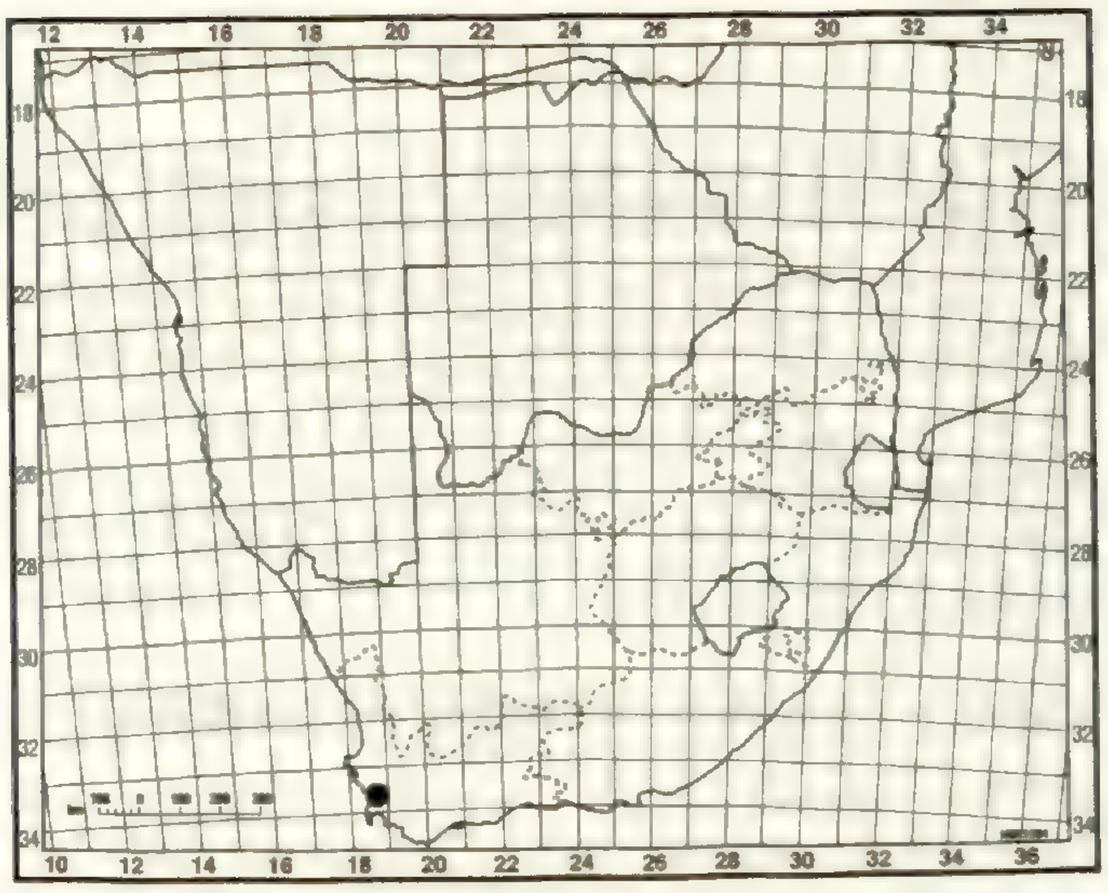


FIG. 149.—**Fontinalis squamosa** (1–6): **1.** habit (dry), × 1; **2.** part of stem in cross section, × 175; **3.** stem leaf, × 35; **4.** branch leaf, × 32; **5.** basal leaf cells (left side), × 160; **6.** branch leaf apex, × 160. **F. antipyretica** var. **gracilis** (7–11): **7.** habit (dry), × 1; **8.** branch leaf, × 35; **9.** branch leaf (side view), × 35; **10.** upper laminal cells, × 320; **11.** branch leaf apex, × 175. (1–6, *Oliver 9052*; 7–9 & 11, *Oliver PRE-CH13598*; 10, *Mogg 2837*.)



MAP 209.—**Fontinalis squamosa**

River in Jonkershoek Valley. The collection was mixed with *F. antipyretica* but it is unclear whether they were growing intermixed. Map 209.

Voucher: *Oliver 9052.*

The rather unusual condition of the South African specimens of *F. antipyretica* not showing the keeled leaf condition, unless wet, has no doubt masked the presence of *F. squamosa* in South Africa. More collections of *Fontinalis* may extend the range of this exotic taxon to other areas where *F. antipyretica* is known to occur.

Fontinalis squamosa is very similar to the more widespread species *F. dalecarlica* B.S.G. The two species differ in the development of leaf marginal cells. The specimens of *F. squamosa* show little or no change in cell size toward the margins, but exhibit a faint yellow tint on the 1–3 cells along the leaf margins. The cells of *F. dalecarlica* become slightly narrower toward the margins and do not exhibit a colour change. *F. dalecarlica* is not found in the United Kingdom, the apparent source of the introduced fish.

WARDIACEAE

The family Wardiaceae, containing a single genus and species, is endemic to the southwestern Cape. The plants are found on rock in mountain streams and are recognized by their blackish colour, mostly ecostate leaves and enlarged alar cells. The alar cells are fragile and frequently eroded away by stream action or left on the stem when leaves are removed.

WARDIA

Wardia *Harv. & Hook.* in Companion Bot. Mag. 2: 183 (1837); Broth. in Natürl. PflFam., edn 2, 11: 55 (1925); Sim, Bryo. S. Afr. 353 (1926). Type species: *W. hygrometrica* Harv. & Hook.

Plants in loose mats, usually blackish green; aquatic and saxicolous. *Stems* branched above stipe; central strand absent. *Leaves* erect to spreading wet, appressed dry; variable in size and shape; acute to cuspidate; margins plane, entire. *Costa* highly variable, absent, present only in base, discontinuous and present at base and apex only, or rarely strong and extending from base to apex; in section cells thickened, not differentiated. *Laminal cells* linear-fusiform, thickened; alar cells strongly differentiated, enlarged and inflated, hyaline to yellowish.

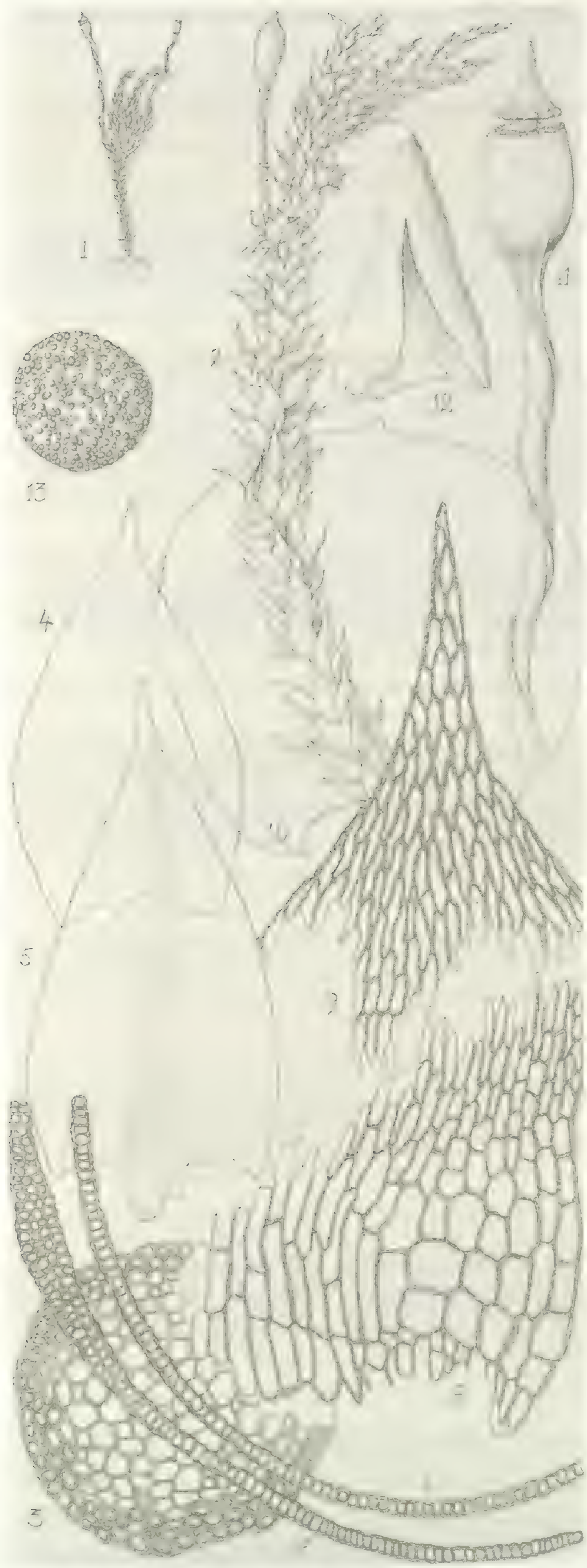
Dioicous or rarely autoicous. *Seta* short and thick. *Capsule* exserted, erect, systylous. *Peristome* very short, exostome teeth truncate. *Operculum* curved-rostrate, attached to columella, persistent. *Calyptra* small, cucullate. *Spores* large, finely granulate.

Wardia hygrometrica *Harv. & Hook.* in Companion Bot. Mag. 2: 183 (1837); Sim, Bryo. S. Afr. 354 (1926); Broth. in Natürl. PflFam., edn 2, 11: 56 (1925); Welch in Bryologist 46: 27 (1943). Type: Cape of Good Hope, Table Mountain, *Harvey s.n.*

Fontinalis duthieae Dix. in Sim, Bryo. S. Afr. 354 (1926); Welch in Bryologist 50: 187 (1947). Syntypes: South Africa, Platteklip Rock, Cape Town, *Sim 9389*; Table Mt, *Sim 9385* (PRE).

Plants small to large, forming mats, dark green or yellow-green to blackish green; aquatic and saxicolous, in splash zone or submerged. *Stems* naked and black below when old, suberect, 15–80 mm long, branching irregular above stipe, subfastigiate; in section round to oval, central strand absent, inner cortical cells large, thin-walled, hyaline, in 5 or 6 rows, outer cortical cells smaller, yellowish, thick-walled, in 5 or 6 rows, epidermis absent; axillary hairs not seen; paraphyllia absent; pseudoparaphyllia absent. *Leaves* evenly spaced, spreading to erect-appressed wet, appressed dry, ± concave; on stipe lanceolate to triangular, 1.5–2.0 mm long; acute; margins plane, entire, eroded; upper stem and branch leaves variable; narrowly or broadly elliptical or short and broadly oblong, 1.2–2.2 mm long; acute to narrowly acuminate or occasionally mucronate to apiculate; rounded at base; margins plane, entire, cells not differentiated. *Costa* variable, absent, present only at base, present and discontinuous only at apex and base, or single and strong throughout, smooth; ventral and dorsal surface cells elongate; in section flat below, round above, guide cells not differentiated, in best development consisting of 3–6 rows of undifferentiated, thickened cells; most leaves with bistratose region at extreme base and thickened awn at apex. *Upper laminal cells* linear-fusiform and somewhat sigmoid, homogeneous, 57–89 µm long, 7–10 µm wide, walls thickened or rarely thin, smooth; basal cells linear to long-rectangular, 50–125 µm long, 7–10 µm wide, brownish yellow, walls incrassate, smooth; alar cells strongly differentiated, forming distinct groups, enlarged and inflated, hyaline, walls thin.

Dioicous or rarely autoicous. *Perichaetia* at apex; perichaetial leaves numerous, broadly ovate, apex acute, sheathing below. *Seta* 4–6 mm long, yellow-brown to blackish, twisted clockwise when dry, smooth, thick. *Capsule*



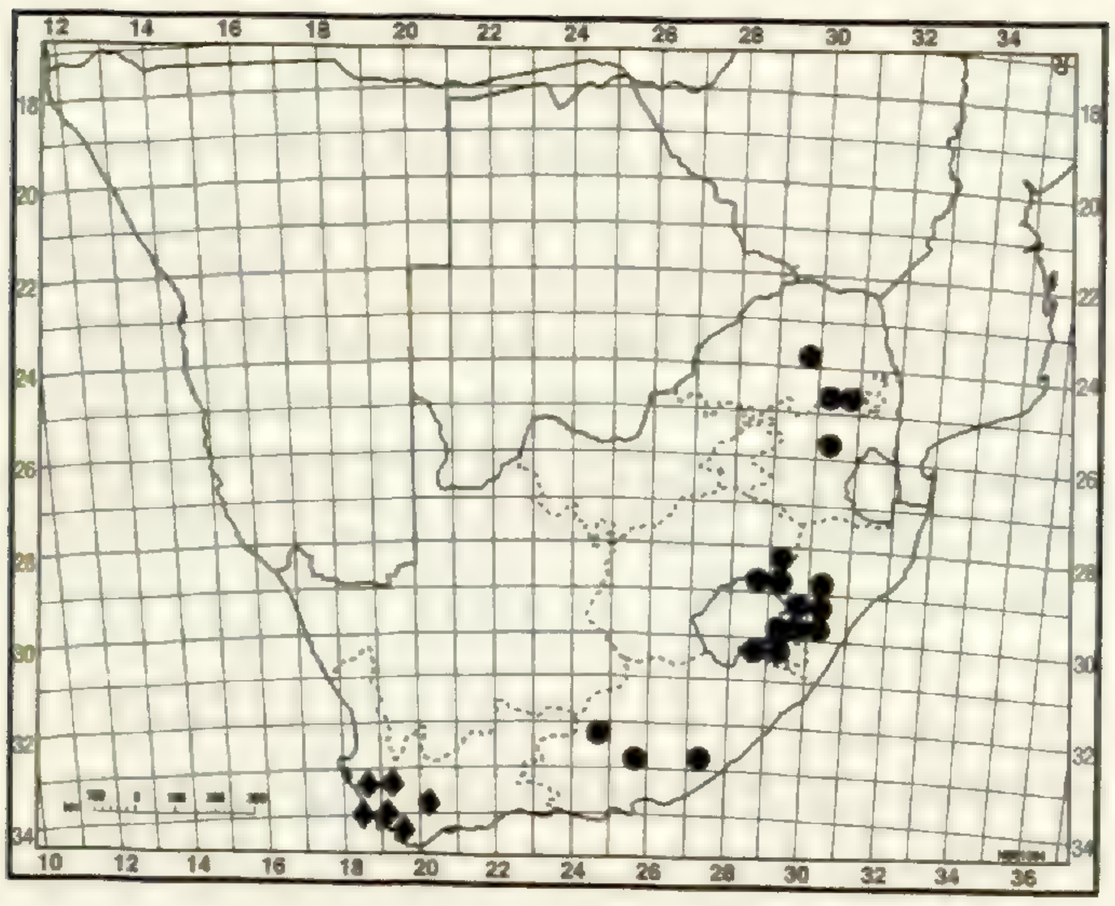
exserted, erect, short-cylindrical or rarely ovoid, 1.0–2.2 mm long, smooth but somewhat ribbed when young and dry, yellow-brown to black; urn short-cylindrical; neck not differentiated; exothecial cells irregular, rounded to quadrate or hexagonal, walls incrassate, cells at mouth quadrate, darker; annulus not differentiated, neck cells hexagonal to rectangular, thickened; stomata absent. *Peristome* rudimentary, yellow to orange; exostome teeth irregular, short-rectangular, truncate, erect, 40–50(–95) µm high, smooth with irregular prostome development; endostome absent. *Operculum* curved-rostrate, attached to columella, persistent, 1.0–1.3 mm long. *Calyptra* not seen. *Spores* rounded, 25–31 (–37) µm, granulate, brown. Fig. 150.

Endemic to southern Africa, *W. hygrometrica* is found in mountain streams of the south-western Cape. Most specimens have been collected on Table Mountain, fertile ones mostly between October and February. Map 210.

Vouchers: *Bews 8498; Crosby & Crosby 8185; Esterhuysen 24545; Thorne PRE-CH3442.*

Although presently restricted in distribution, *W. hygrometrica* expresses a high degree of gametophytic variability. Plants show variation in stem length and firmness, as well as the stage at which stipes develop. This variation in habit appears to be related to the age of individual plants, younger plants being small, flaccid and without a differentiated stipe, while older plants are long, stout and frequently have well developed stipes. Variation in leaf size and shape is frequently considerable between individual collections. Much of the gametophytic variation expressed by this species could be a result of the semi-aquatic nature of the plants.

FIG. 150.—**Wardia hygrometrica**: **1.** habit (dry), × 1; **2.** habit (wet), × 3; **3.** stem in cross section, × 175; **4.** ecostate leaf, × 35; **5.** costate leaf, × 35; **6.** part of ecostate leaf in cross section, × 175; **7.** part of costate leaf in cross section, × 175; **8.** basal leaf cells (right side), × 175; **9.** cells at leaf apex, × 175; **10.** perichaetial leaf, × 35; **11.** distal part of sporophyte (dry), × 10; **12.** calyptra, × 17; **13.** spore, × 700. (1, 2 & 11, *Wager CH11690*; 3, 4, 6, 8 & 9, *Van Zanten 7608227*; 5 & 7, no collector given, *CH8648*; 10 & 13, *Harrison BOL 24917*; 12, *Sim 9257*.)



MAP 210.— ♦ **Wardia hygrometrica**
● **Hedwigia ciliata**

The presence of a costa in some specimens of *Wardia* was first noted by Allen (1987) when he discovered a small bistratose area at the extreme base of some leaves. He further found that the discoloured acumen in most leaves was multistratose. The costa was therefore interpreted as discontinuous and completely lacking from the middle of the leaf. More recently specimens have been found (*PRE-CH8648*) with well developed costae, extending from base to apex. This is the first report of specimens with fully developed costae.

The sporophyte is also adapted to the aquatic habitat as seen in the short, stout setae, and absence of stomata. The operculum remains attached to the columella after the capsule has opened. At the point of attachment, inside the base of the operculum, is a large plug of tissue that is normally broken down during the final stages of peristome development. This is in part responsible for the short, truncate peristome teeth that are just visible at the capsule mouth.

The type of *Fontinalis duthieae* Dix. in Sim was found to be a light-coloured, somewhat attenuate specimen of *W. hygrometrica*. The leaves illustrated by Sim are not outside the range of those found on other specimens of *W. hygrometrica*; furthermore the laminal and alar cells clearly indicate the relationship of his specimens.

HEDWIGIACEAE

Plants medium to large, erect to creeping, grey-green or yellow-green to green, occasionally with reddish tint; saxicolous, corticolous or terricolous. *Stems* ± julaceous, freely branched; in section central strand absent or weak; paraphyllia absent; pseudoparaphyllia absent or filamentous. *Leaves* appressed dry, widespreading wet, frequently with hyaline or reddish apex; broadly ovate to elliptical; acute to acuminate or sometimes piliferous; margins recurved below, entire to serrulate, frequently decurrent at base. *Laminal cells* quadrate to rectangular or sometimes fusiform, generally incrassate and pitted, papillose or granulose; basal cells longer; alar cells quadrate, sometimes strongly differentiated.

Autoicous or dioicous. *Perigonia* terminal or axillary, gemmate. *Perichaetia* terminal on stems or short branches, not strongly differentiated; perichaetial leaves imbricate, oblong, margins entire, serrulate or ciliate. *Seta* short or long. *Capsule* immersed or exserted, cupulate to cylindrical, occasionally weakly ribbed, gymnostomous. *Operculum* rostrate, beak curved. *Calyptra* cucullate. *Spores* small to medium-sized, brown or greenish.

A small mostly southern hemisphere family of five genera, four of which occur in the *Flora* area. The genera are generally recognized by their extensive, loose tufts formed over exposed rock surfaces at higher elevations.

1 Leaf cells granulate, alar cells strongly differentiated . . . . . 1. **Rhacocarpus**
1 Leaf cells papillose, alar cells not strongly differentiated:
2 Leaf apex hyaline, at least at stem tips:
3 Plants grey-green, leaf cell papillae large, 1 or 2 per cell; perichaetial leaf margins ciliate; capsule immersed . . . . . 2. **Hedwigia**
3 Plants green to yellow-green; leaf cell papillae small, scattered over surface; perichaetial leaves entire; capsule exserted . . . . . 3. **Braunia**
2 Leaf apex green or yellow-green:
4 Leaves somewhat plicate when dry; capsule exserted . . . . . 3. **Braunia**
4 Leaves not plicate when dry; capsule immersed . . . . . 4. **Hedwigidium**

1. RHACOCARPUS

Rhacocarpus *Lindb.*, in Ofvers. Forh. Kongl. Svenska Vetensk.-Akad. 19: 607 (1863); Sim, Bryo. S. Afr. 352 (1926); Broth. in Natürl. PflFam., edn 2, 11: 73 (1925); Sainsb., N. Zeal. mosses 334 (1955). Type species: *R. humboldtii* (Hook.) Lindb.

Harrisonia Spreng., Syst. veg. 4,1: 145 (1827), hom. illeg.

Plants large, creeping, yellow-green to grey-green, frequently tinted with red; saxicolous or terricolous. *Stems* frequently highly branched; central strand absent. *Leaves* ovate to oblong, frequently with reddish hair-point; margins recurved below, serrulate above; ecostate. *Laminal cells* fusiform, densely granulate, incrassate and pitted; marginal cells smooth; alar cells strongly differentiated, enlarged, coloured.

Dioicous. *Capsule* exserted, weakly ribbed. *Peristome* absent. *Operculum* rostrate. *Calyptra* cucullate, reddish. *Spores* medium-sized.

Rhacocarpus contains 22 species that are, with the exception of a single Central American species, restricted to the southern hemisphere. Except for the gymnostomous capsules, the genus

has little in common with other genera of the family. The single southern African species is rather restricted in its local distribution, but widely distributed throughout the hemisphere.

Rhacocarpus purpurascens *(Brid.) Par.*, Index bryol. suppl. 292 (1900); Broth. in Natürl. PflFam., edn 2, 11: 75 (1925); De Sloover in Bull. Jard. Bot. Belg. 43: 343 (1973); Scott & Stone, Moss. S. Austr. 356 (1976). Type: Réunion.

Hypnum purpurascens Brid., Muscol. recent. suppl. 2: 121 (1812).

Harrisonia breuteliana C. Müll. in Oesterr. Bot. Z. 47: 392 (1897). *Rhacocarpus breutelianus* (C. Müll.) Broth. in Natürl. PflFam. 1,3: 720 (1905). Type: South Africa, Saldanha Bay, *Breutel 1862*.

Harrisonia eckloniana C. Müll. in Oesterr. Bot. Z. 47: 398 (1897). *Rhacocarpus ecklonianus* (C. Müll.) Broth. in Natürl. PflFam. 1,3: 722 (1905); Sim, Bryo. S. Afr. 352 (1926). Syntype: South Africa, Cape Town, Table Mountain, *Rehmann 197, 314* (PRE).

Harrisonia gracillima C. Müll. in Oesterr. Bot. Z. 47: 391 (1897). *Rhacocarpus gracillimus* (C. Müll.) Broth. in Natürl. PflFam. 1,3: 720 (1905). Type: South Africa, Cape Town, Table Mountain, *Rehmann 312*.

Harrisonia rehmanniana C. Müll. in Oesterr. Bot. Z. 47: 391 (1897). *Rhacocarpus rehmannianus* (C. Müll.) Wijk et Marg. in Taxon 9: 52 (1960); Sim, Bryo. S. Afr. 353 (1926). Syntypes: South Africa, Cape, Table Mountain, *Rehmann 313*; *Ecklon s.n.*; Montague Pass, *Rehmann*, Oct. 1875; Saldanha Bay, *Breutel s.n.*, 1862 (G?).

Plants medium to large, forming large, loose tufts, yellow-green to grey-green, frequently tinged with red, yellow at apex, brown to black below; saxicolous or terricolous. *Stems* creeping, to 100 mm long, branches numerous; in section round, central strand absent, inner cortical cells large, hyaline, in 3–5 rows; outer cortical cells smaller, red-yellow, thick-walled, in 2 or 3 rows, axillary hairs few, 2 or 3 cells long, basal cells brown; pseudoparaphyllia absent. *Leaves* evenly spaced, widespreading wet, appressed with reflexed tips dry; stem leaves ovate to oblong, 1.5–2.0 mm long; acute to acuminate; apex frequently hair-pointed, awn reddish, weakly narrowed to insertion; margins recurved and reddish below, plane to broadly inflexed above, serrulate above, faintly bordered; ecostate. *Upper laminal cells* fusiform, somewhat sigmoid, heterogeneous, 12–75 µm long, 6–12 µm wide, walls incrassate and pitted, densely granulate on both surfaces, border cells in 2–16 rows, narrower and smooth, thicker in section; basal cells somewhat longer but not strongly differentiated, 60–100 µm long, 8–12 µm wide, greenish yellow, reddish across insertion, walls incrassate and pitted, densely granulate; alar cells strongly differentiated and forming distinct groups, quadrate to short rectangular, reddish, smooth, thin-walled.

Perigonial leaves ovate-acute, 1 mm long. *Perichaetial leaves* oblong-acuminate, imbricate, 2.5–3.0 mm long, margins weakly serrulate; leaf cells rectangular, incrassate and pitted. *Seta* 6 mm long, yellow-brown, smooth. *Capsule* exserted, erect, ellipsoid, 2 mm long, weakly ribbed, yellow-brown, gymnostomous; neck shorter than urn; exothecial cells rounded to quadrate, walls thin, cells at mouth quadrate to transversely short-rectangular, neck cells smaller, quadrate, thickened; stomata on neck, numerous, phaneropore. *Operculum* conic-rostrate, beak curved, 0.5 mm long. *Calyptra* cucullate, reddish, 1 mm long, smooth. *Spores* not seen. Fig. 151: 1–11.

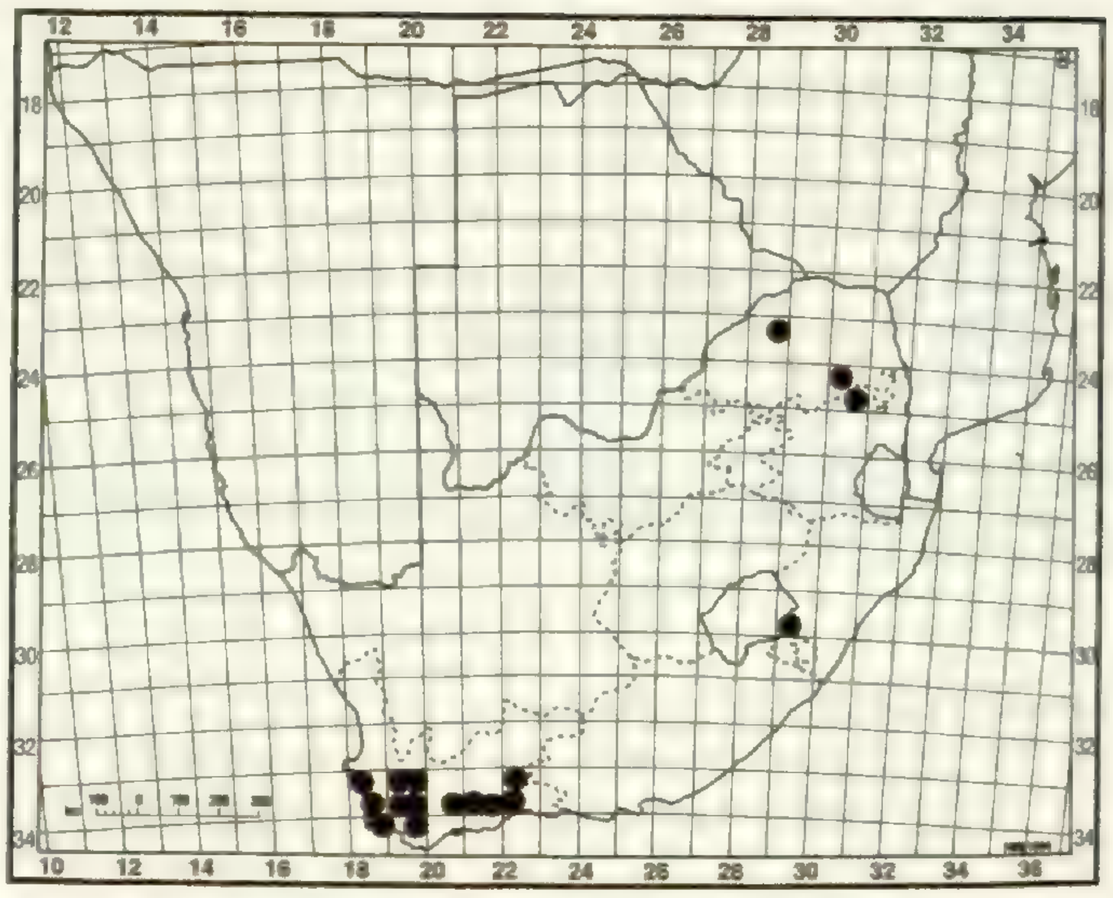
Rhacocarpus purpurascens is found in Central and South America, the West Indies, eastern and southern Africa, the East African islands, Australia and New Zealand and some southern temperate and subantarctic islands. In southern Africa the plants are rather restricted in

FIG. 151.—**Rhacocarpus purpurascens** (1–11): **1.** habit (dry), × 1; **2.** habit (wet), × 5; **3.** stem in cross section (cells partly shown), × 175; **4 & 5.** leaves, × 35; **6.** leaf in cross section, × 175; **7.** basal leaf cells (right side), × 175; **8.** upper laminal cells, × 350; **9.** upper laminal cells at right margin, × 350; **10.** leaf apex, × 175; **11.** perichaetial leaf, × 32. **Hedwigia ciliata** (12–21): **12.** habit (dry), × 1; **13.** habit (wet), × 5; **14.** part of stem in cross section, × 175; **15.** leaf, × 25; **16.** leaf in cross section, × 175; **17.** basal leaf cells at right margin (papillae partly shown), × 175; **18.** upper laminal cells, × 350; **19.** leaf apex, × 175; **20.** perichaetial leaf, × 25; **21.** spore, × 700. (1, 5–7, 9 & 11, *Esterhuysen 15873*; 2, *Bews PRE-CH8665*; 3, 4, 8 & 10, *Magill 4361*; 12 & 13, *Hilliard & Burtt 11841a*; 14–19, *Magill 5674*; 20 & 21, *Magill 7362*.)

distribution. The species is found on wet rock or soil, frequently associated with *Sphagnum* L., in mountains of the northern and eastern Transvaal regions, Lesotho and the southern and south-western Cape. Map 211.

Vouchers: *Anderson 1204; Boucher 3658; Esterhuysen 15873; Magill 4361, 6324; Magill & Schelpe 4061.*

This magnificent moss is easily recognized by its distinctive coloration, densely granulate cell ornamentation and pronounced alar regions. The variations expressed by the plants, i.e. apex angle and hair-point development, width of smooth-celled leaf border, branching pattern and plant size, do not seem to be correlated. However, subspecific names may be required when the species is examined on a worldwide basis. For example, the leaf apex is quite variable in southern Africa. It can be abruptly acuminate with a rather broad acumen filled with thickened and pitted laminal cells, or narrow and extending out into a short or long awn.



MAP 211.—**Rhacocarpus purpurascens**

The fertile specimens were either too young or too old and missing the capsule, and therefore spores were not found. They have been described elsewhere as 20–22 µm in diameter and finely papillose.

2. HEDWIGIA

Hedwigia *P. Beauv.* in Mag. Encycl. 5: 304 (1804), nom. cons.; Sim, Bryo. S. Afr. 348 (1926); Broth. in Natürl. PflFam., edn 2, 11: 67 (1925); Scott & Stone, Moss. S. Austr. 352 (1976); Smith, Moss Fl. Brit. Irel. 492 (1980); Crum & Anderson, Moss. E.N. Amer. 2: 744 (1981). Type species: *H. ciliata* (Hedw.) P. Beauv.

Plants large, glaucous green; saxicolous. *Stems* erect or prostrate, irregularly branched; central strand small. *Leaves* crowded, patent wet, broadly elliptical, concave, acuminate apex hyaline, ecostate. *Leaf cells* irregularly rectangular, incrassate, papillose by single, simple or branched papillae centred over lumens; papillae 2–6 and seriate on linear, interior basal cells.

Autoicous. *Seta* very short. *Capsule* immersed, cupulate. *Peristome* absent. *Operculum* convex. *Calyptra* cucullate. *Spores* small, brown.

A genus generally considered to contain only one species, *H. ciliata*. The species does exhibit much variability and this has resulted in the description of a large number of subspecific taxa. The genus is rather widely distributed on exposed rock in temperate forest throughout the world.

Hedwigia ciliata *(Hedw.) P. Beauv.*, Prodr. aethéogam. 15 (1805); Smith, Moss Fl. Brit. Irel. 492 (1978); Scott & Stone, Moss. S. Austr. 354 (1976); Catcheside, Moss. S. Austr. 295 (1980). Type: North America.

Anictangium ciliatum Hedw., Sp. musc. frond. 40 (1801).

Hedwigia albicans Lindb. in Ofvers. Forh. Kongl. Svenska Vetensk.-Akad. 21: 421 (1864); Sim, Bryo. S. Afr. 349 (1926); Broth. in Natürl. PflFam., edn 2, 11: 68 (1925). Type: not given.

Hedwigia macowaniana C. Müll. in Flora 71: 415 (1888). Type: South Africa, Cape, Somerset East, *MacOwan s.n.*

Hedwigia macowaniana C. Müll. in Hedwigia 38: 122 (1899), hom. illeg. *Hedwigia ciliata* fo. *macowaniana* (C. Müll.) Fleisch. in Hedwigia 61: 403 (1920). Type: South Africa, Cape, Mt. Boschberg, *MacOwan s.n.*, July 1877 (GRA, H).

Hedwigia macowani C. Müll. ex Dix. & Gepp in Bull. Misc. Inform. 1923: 229 (1923), nom. illeg. Type: South Africa, 'Musci MacOwanianis No. 19'; sub *Rehmann 596, 596b, 596c* (PRE).

Plants large, forming extensive, loose tufts, glaucous, grey-green to yellow-green; saxicolous. *Stems* julaceous, erect to pendent, to 70 mm long, branching irregular; in section round, central strand not well defined, inner cortical cells thin-walled, yellow, in 4–6 rows, outer cortical cells thick-walled, smaller, red-brown, in 2 or 3 rows; pseudoparaphyllia filamentous. *Leaves* crowded, patent wet, appressed with weakly spreading hyaline tips dry, concave, frequently secund in prostrate plants; broadly elliptical to ovate, 2.0–2.5 mm long; acuminate; apex hyaline, spinose papillate to almost smooth; weakly decurrent at base; margins plane to narrowly reflexed below, plane above or narrowly recurved at transition to hyaline acumen, entire; ecostate. *Upper laminal cells* irregularly rectangular, homogeneous, 10–25 µm long, 2–10 µm wide, walls incrassate, pitted, papillose on both surfaces; papillae single, centred over lumen, simple or branched; basal cells rectangular toward margins, linear in centre and strongly differentiated, 30–150 µm long, 6–12 µm wide, yellow to brownish, walls incrassate, pitted and irregular, papillose, papillae 2–6, seriate and centred over lumens; alar cells quadrate, brownish, walls thickened, smooth.

Perigonial leaves ovate-acuminate, 1 mm long. *Perichaetial leaves* imbricate; oblong to elliptical, 2.5–3.5 mm long; acuminate; margins with long, hyaline, ciliate hairs; leaf cells irregularly rectangular to angular, incrassate above, rectangular below, thickened, pitted. *Seta* up to 1 mm long, yellow, smooth. *Capsule* immersed, erect, gymnostomous, oblate to cupulate, 1–2 mm long, smooth, yellow to yellow-brown; neck shorter than urn; exothecial cells ± rectangular to angular, walls thickened, cells at mouth becoming smaller, rounded and collenchymatous, in 10–15 rows, neck cells irregular rectangular, thin-walled; stomata not seen. *Operculum* convex and minutely beaked, 0.5 mm long. *Calyptra* small, cucullate. *Spores* rounded to angular, 22–26 µm, verruculose, brown. Fig. 151: 12–21.

Widespread on rocks in forest or forest margins, frequently in exposed situations, *H. ciliata* is known throughout the temperate to arctic northern hemisphere, Central and South America, eastern and southern Africa and Madagascar, Australia, Tasmania and New Zealand. In southern Africa this species is uncommon in the northern and eastern Transvaal regions, KwaZulu-Natal, Lesotho and the eastern and central Cape areas. Map 210.

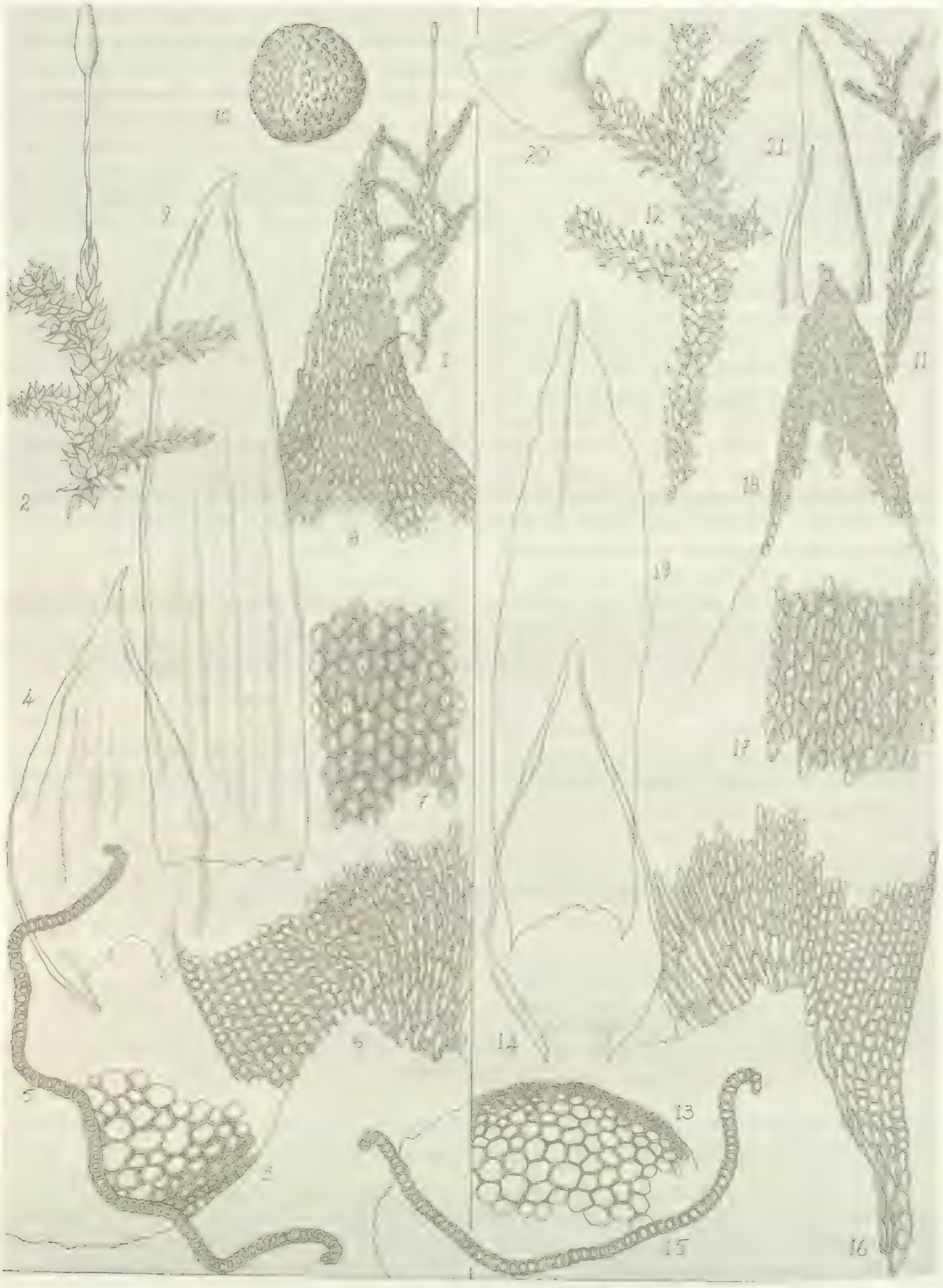
Vouchers: *Hilliard & Burtt 11841; Magill 6947, 7424; Van Rooy & Perold 3857.*

Hedwigia ciliata is most easily identified by its grey-green colour, large leaf cell papillae and pronounced hyaline leaf apex. Specimens are uncommon but usually cover large areas on exposed boulders in forest openings or margins. The plants are generally collected with sporophytes, a condition that is not as common in other members of the family. The cup-shaped capsules are immersed, but their orange urns and reddish mouths are generally apparent through the large, ornately ciliate perichaetial leaves.

3. **BRAUNIA**

Braunia *B.S.G.*, Bryol. eur. 3: 159 (1846); Sim, Bryo. S. Afr. 350 (1926); Broth. in Natürl. PflFam., edn 2, 11: 70 (1925). Type species: *B. sciuroides* (Bals. & De Not.) B.S.G.

Plants large, loosely caespitose; saxicolous or corticolous. *Stems* suberect, branched; central strand present. *Leaves* widespreading wet, broadly elliptical, ± plicate; margins narrowly recurved; apex frequently hyaline; ecostate. *Laminal cells* quadrate to rectangular, thickened, papillose; interior basal cells linear, seriate papillose.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Autoicous. *Seta* elongate, smooth. *Capsule* long-exserted. *Peristome* absent. *Operculum* rostrate, beak curved. *Calyptra* cucullate. *Spores* small, brown.

Braunia contains 23 species scattered in the Americas, Africa and Asia. One species, *B. secunda*, found throughout the range of the genus, is known from southern Africa.

Braunia secunda *(Hook.) B.S.G.*, Bryol. eur. 3: 161 (1846); Sim, Bryo. S. Afr. 350 (1926); Broth. in Natürl. PflFam., edn 2, 11: 71 (1925); Grout, Moss Fl. N. Amer. 2: 44 (1933). Type: Mexico, *Humboldt & Bonpland s.n.*

Hedwigia secunda Hook., Musci exot. 1: 46 (1818). *Anictangium secundum* (Hook.) Hook. in Kunth, Syn. pl. 1: 47 (1822).

Neckera diaphana C. Müll., Syn. musc. frond. 2: 105 (1850). *Braunia diaphana* (C. Müll.) Jaeg. in Ber. Thätigk. St. Gallischen Naturwiss. Ges. 1874–1875: 172 (1876). Type: Prom. bon. spei, *Pappe s.n.*

Braunia secunda var. *pinnata* Sim, Bryo. S. Afr. 351 (1926). Type: South Africa, Natal, Giant's Castle, 1915, *Symons s.n.* sub *Sim 10266* (PRE).

Plants large, forming extensive tufts, green to yellow-green; saxicolous or corticolous. *Stems* suberect, 20–70 mm long, branching irregular; in section round, central strand absent, inner cortical cells thick-walled, yellow, in 5–7 rows, outer cortical cells smaller, thick-walled, red-brown, in 2 or 3 rows; pseudoparaphyllia absent. *Leaves* evenly spaced, patent to widespreading wet, weakly appressed dry, plicate; broadly elliptical to ovate-lanceolate, 2.0–2.5 mm long; acute to acuminate; apex frequently hyaline and papillose, especially at stem tips; base weakly decurrent; margins narrowly recurved frequently throughout, entire below, sometimes toothed at apex; ecostate. *Upper laminal cells* quadrate to rectangular, frequently irregular, homogeneous, 7–16 µm long, 6–8 µm wide, walls incrassate, papillose on both surfaces, frequently almost smooth above; papillae numerous, low, scattered; basal cells quadrate to short rectangular marginally, linear and forming distinct group internally, 60–100 µm long, 8–12 µm wide, yellowish, walls thickened, weakly pitted, papillose, papillae low, seriate; alar cells not strongly differentiated.

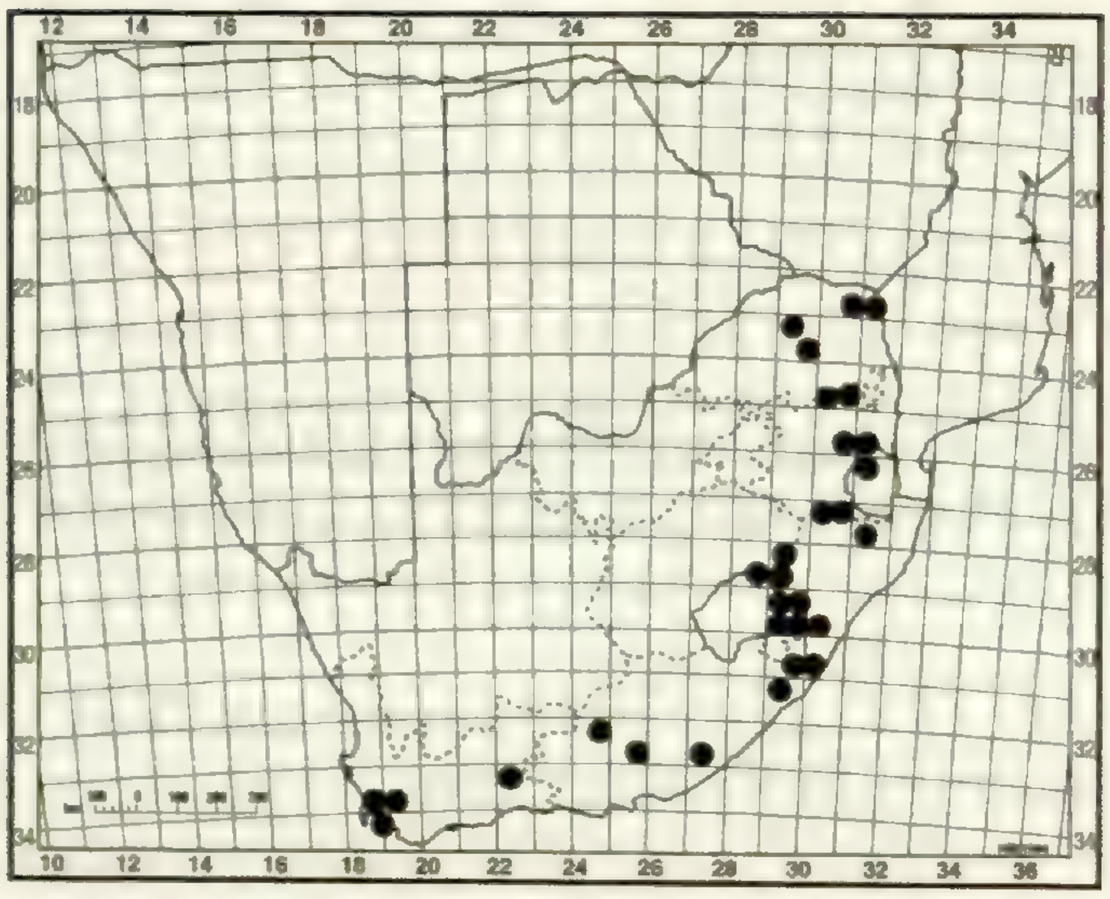
Perigonial leaves ovate-acute, 1.0–1.2 mm long. *Perichaetial leaves* oblong-acuminate, 3 mm long; margins entire; leaf cells quadrate to short rectangular above, papillose, rectangular to linear below, smooth, incrassate and pitted. *Seta* 10–15 mm long, yellow-brown, smooth. *Capsule* exserted, ± erect, gymnostomous, cylindrical, 2.0–3.5 mm long, smooth, yellow-brown, neck shorter than urn; exothecial cells rounded, quadrate to oblong, walls thickened, cells at mouth darker, quadrate, thickened, neck cells not differentiated; stomata numerous on neck, phaneropore. *Operculum* short- or long-beaked, curved, 1 mm long. *Calyptra* cucullate. *Spores* angular, 22–27 µm, papillose, brownish green. Fig. 152: 1–10.

Braunia secunda is known from the southwestern United States, the West Indies through Central America to Bolivia and northern Argentina, northern, southern and eastern Africa and India. In the *Flora* area the species is found on boulders and at the base of trees in open sites in forests or shaded kloofs of the northern and eastern Transvaal regions, Swaziland, Zululand, KwaZulu-Natal, and the central, eastern, southern and southwestern Cape. Map 212.

Vouchers: *Abbott 7112; Esterhuysen 17678; Hilliard & Burtt 17139; Magill 3485, 6951; Meyer 2516g.*

Specimens of *Braunia secunda* are quite variable but are generally easily placed when they

FIG. 152.—**Braunia secunda** (1–10): **1.** habit (dry), × 1; **2.** habit (wet), × 3; **3.** part of stem in cross section, × 175; **4.** leaf, × 35; **5.** leaf in cross section, × 175; **6.** basal leaf cells (left side), × 175; **7.** upper laminal cells, × 350; **8.** leaf apex, × 175; **9.** perichaetial leaf, × 35; **10.** spore, × 700. **Hedwigidium integrifolium** (11–21): **11.** habit (dry), × 1; **12.** habit (wet), × 3; **13.** part of stem in cross section, × 175; **14.** leaf, × 35; **15.** leaf in cross section, × 175; **16.** basal leaf cells (right side), × 175; **17.** upper laminal cells, × 350; **18.** cells at leaf apex, × 175; **19.** perichaetial leaf, × 32; **20.** operculum, × 35; **21.** calyptra, × 35. (1–10, *Sipman 20021*; 11 & 13–20, *Van Rooy 2270*; 12, *Scheepers 1228*.)



MAP 212.—**Braunia secunda**

form large, yellow-green carpets over exposed boulders in forest openings. The ecostate leaves generally have a hyaline apex, especially at the stem tips, although never as pronounced as in *Hedwigia ciliata*. The leaves are also generally distinctly plicate when dry, a condition that separates this species from *H. ciliata* and *Hedwigidium integrifolium* (see below).

Fertile specimens are uncommon, but are easily separated from *Hedwigidium* and *Hedwigia* by their long-exserted, cylindrical capsules. The dryness of the open rock habitat may account in part for the rarity of sporophytes, an unusual fact considering the autoicous nature of the plants.

4. HEDWIGIDIUM

Hedwigidium *B.S.G.*, Bryol. eur. 3: 155 (1846); Sim, Bryo. S. Afr. 349 (1926); Broth. in Natürl. PflFam., edn 2, 11: 69 (1925). Type species: *H. imberbe* (Sm.) B.S.G.

Plants generally large, forming extensive loose tufts, yellow-green; generally saxicolous. *Stems* suberect to creeping, branches few; central strand absent. *Leaves* patent wet, appressed dry, elliptical-acuminate, apex green; margins weakly recurved below, entire, decurrent; ecostate. *Laminal cells* rectangular, incrassate, walls frequently wavy.

Autoicous. *Seta* short. *Capsule* immersed, cupulate. *Peristome* absent. *Operculum* conic-rostrate, beak curved. *Calyptra* cucullate, smooth. *Spores* brownish.

A genus with a single species found in Central and South America, Europe, southern Asia and India, central and southern Africa, Australia and New Zealand. The species has been treated by several authors (Smith 1978) as belonging to *Hedwigia*, to which it is related.

Hedwigidium integrifolium *(P. Beauv.) Dix.* in C. Jens., Skand. Bladmossfl. 369 (1939). Type: North America.

Hedwigia integrifolia P. Beauv., Prodr. aethéogam. 60 (1805); Smith, Moss Fl. Brit. Irel. 493 (1978); Scott & Stone, Moss. S. Austr. 355 (1976).

Gymnostomum imberbe Sm., Engl. bot. 32: 2237 (1811). *Hedwigidium imberbe* (Sm.) B.S.G., Bryol. eur. 3: 157 (1846); Sim, Bryo. S. Afr. 349 (1926). *Hedwigia imberbis* (Sm.) Spruc., Musc. pyren. 263 (1847). Type: Ireland, *Hutchins*, 1809.

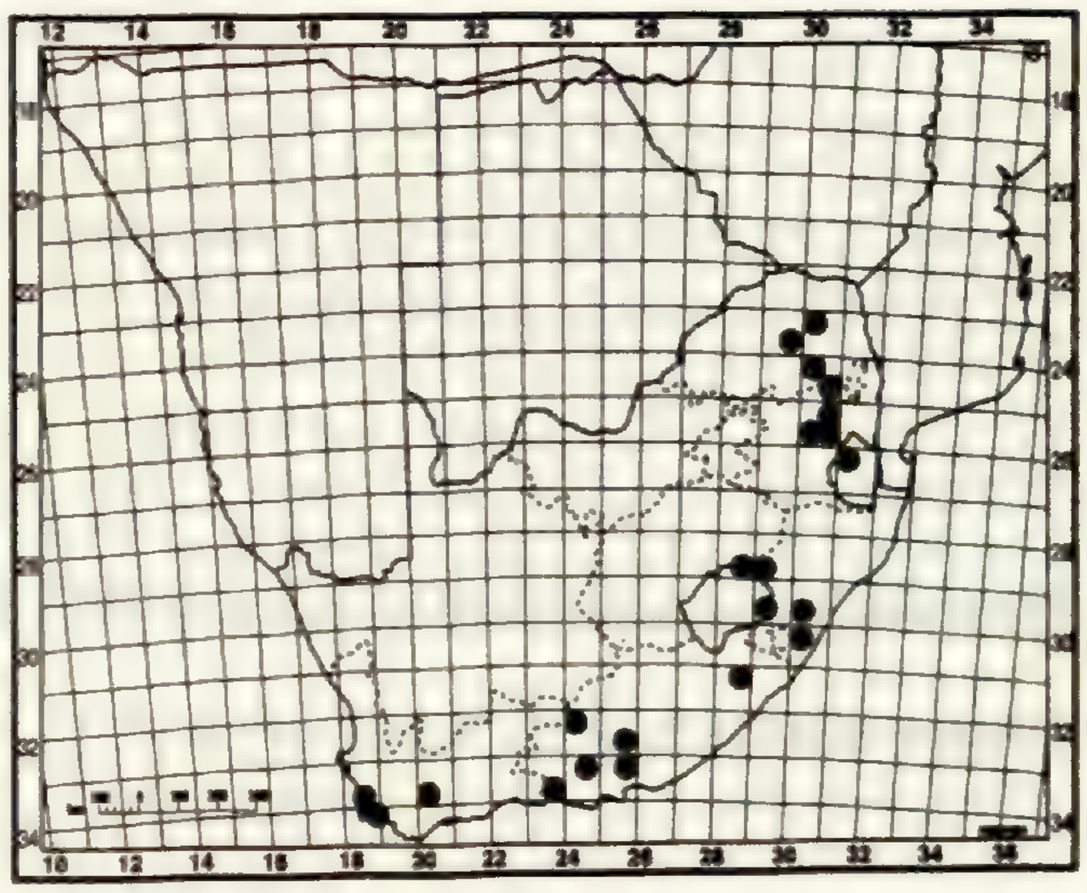
Braunia macowaniana C. Müll. in Hedwigia 38: 123 (1899). Syntypes: South Africa, Cape, Somerset East, Mt Boschberg, *MacOwan s.n.*; Natal, Jammerlappen, *Dittrich*, 1898 (PC).

Braunia erosa C. Müll. in Hedwigia 38: 124 (1899). Type: South Africa, Cape Prov., Cape Town, near Rondebosch, 1875, *Rehmann s.n.* (BM).

Braunia maritima C. Müll. in Hedwigia 38: 124 (1899). *Hedwigidium maritimum* (C. Müll.) Par., Index bryol. suppl. 179 (1900). Syntypes: South Africa, Cape Prov., Table Mountain, *Rehmann 306, 307*; Transvaal, Lydenburg, *Wilms s.n.*, 1887 (BM).

Plants medium to large, forming large tufts, yellow-green to yellow-brown; saxicolous or humicolous. *Stems* suberect to creeping, up to 50 mm long, branches few, irregular; in section round, central strand absent, inner cortical cells large, yellowish, in 3 or 4 rows, outer cortical

cells smaller, thick-walled, reddish; axillary hairs few, 3 cells long, basal cell brown; pseudoparaphyllia absent. *Leaves* crowded, patent wet, appressed dry; elliptical to lanceolate, 1.5–2.5 mm long; acuminate, decurrent at base; margins plane or recurved to above midleaf, entire; ecostate. *Upper laminal cells* rectangular or quadrate, homogeneous, 8–18 µm long, 5–7 µm wide, walls incrassate, frequently wavy, weakly papillose; papillae low, scattered; basal cells strongly differentiated internally, linear, 35–75 µm long, 5–8 µm wide, reddish yellow, walls incrassate, pitted, smooth; alar cells not strongly differentiated from laminal cells, somewhat larger, quadrate to rectangular, yellow-brown, walls thickened.



MAP 213.—**Hedwigidium integrifolium**

Perigonial leaves ovate-acuminate, 1 mm long. *Perichaetial leaves* oblong; acute to acuminate, 3–4 mm long; base sheathing; margins serrulate at midleaf; leaf cells quadrate to short-rectangular and papillose above, linear and smooth below. *Seta* 0.8–1.0 mm long, brown, smooth. *Capsule* immersed, erect, gymnostomous, cupulate, 1.5 mm long, weakly ribbed, yellow to brown; neck not differentiated; exothecial cells rounded quadrate, walls thin, cells at mouth darker, quadrate; stomata not seen. *Operculum* conic-rostrate, beak curved, 0.5 mm long. *Calyptra* cucullate, 1 mm long, smooth, yellow-brown. *Spores* rounded angular, 20–25 µm, granulate, brown. Fig. 152: 11–21.

A rather widespread species known from Central and South America, Europe, western, eastern and southern Africa and the Mascarenes, southern and southeastern Asia, Australia and New Zealand. In the *Flora* area *H. integrifolium* is found on exposed rock or humus over rock in the northern and eastern Transvaal region, Swaziland, KwaZulu-Natal, Lesotho and the eastern, central, southern and southwestern Cape. Map 213.

Vouchers: *Esterhuysen 21233; Crosby & Crosby 8142; Magill 3518; Van Rooy 2270.*

Vegetatively this species resembles *Braunia secunda*, and some specimens are not completely distinguishable because of the variability expressed by both species. The following characters are useful for separating sterile specimens of the two species. The leaves of *H. integrifolium* are narrower, only rarely weakly plicate when dry and have a yellow-green apex, whereas the leaves of *B. secunda* are generally broad, distinctly plicate when dry, and the apex (at least of those leaves at the stem apex) is hyaline. The leaf cells of *H. integrifolium* also seem to be more regularly rectangular with wavy, incrassate walls.

The sporophyte of *H. integrifolium* is completely immersed and could be easily overlooked since the perichaetial leaves are not strongly differentiated. The autoicous condition should lead to a higher number of plants with sporophytes than have been found on recent collections.

The need for a separate genus for this species has been questioned, since it shares a similar habit and immersed gymnostomous, cupulate capsules with *Hedwigia*. In addition, the midleaf marginal serrulations on the perichaetial leaves may suggest a relationship with the ciliate perichaetial leaves of *Hedwigia*. On the other hand, important character differences exhibited by *Hedwigidium* include the lack of a central strand in the stems, lack of pseudoparaphyllia, absence of a hyaline leaf apex and differences in leaf cell papillae.

CRYPHAEACEAE

A family of eight genera found in forests of temperate and tropical regions. The family is recognized by its branched secondary stems, strongly costate leaves, generally with decurrent bases, autoicous gametophytes, immersed capsules, and conical calyptrae. In the *Flora* area the family is represented by a single genus, *Cryphaea*. The family as defined by Manuel (1973) is more homogeneous than before. However, close ties with genera in Leucodontaceae and Leptodontaceae exist, without clear lines of separation.

CRYPHAEA

Cryphaea *Mohr* in Web., Tab. Calyptr. operc. 3 (1814); Broth. in Natürl. PflFam., edn 2, 11: 77 (1925); Sim, Bryo. S. Afr. 355 (1926); Crum & Anders., Moss. E.N. Amer. 2: 747 (1981). Type species: not designated.

Plants medium-sized, scattered or in very loose tufts, green to yellow-green; corticolous. *Secondary stems* erect from creeping primary stem, loosely pinnate; in section central strand absent. *Leaves* lanceolate, margins entire to serrate, frequently decurrent at base. *Costa* single, strong to near apex. *Laminal cells* short, weakly thickened, smooth; basal cells not strongly differentiated; alar cells quadrate, in large groups.

Autoicous. *Perichaetia* numerous, along secondary stem. *Seta* very short. *Capsule* immersed, cylindrical; stomata absent. *Peristome* single or double and incomplete; exostome teeth recurved when wet. *Operculum* conical. *Calyptra* conical but split along one side. *Spores* large.

A genus of about 68 corticolous species found in forests of temperate and tropical regions. Most species are found in Central America and northern South America. Eight species are known from Africa and the African islands.

The calyptra has been used as one of the major characters separating Cryphaeaceae from Leucodontaceae. The cryphaeaceous calyptra, described as conical or mitrate, has been regarded as distinct from the cucullate calyptra of the Leucodontaceae and was the major reason Manuel (1974) removed *Forsstroemia* from Cryphaeaceae. The southern African species of *Cryphaea* was found to have a conical calyptra split along one side, a condition also found in other species of the genus. Therefore the technical distinction between the split-conical calyptra of *Cryphaea* and the cucullate or hood-shaped calyptra of Leucodontaceae is not as clear as previously suggested.

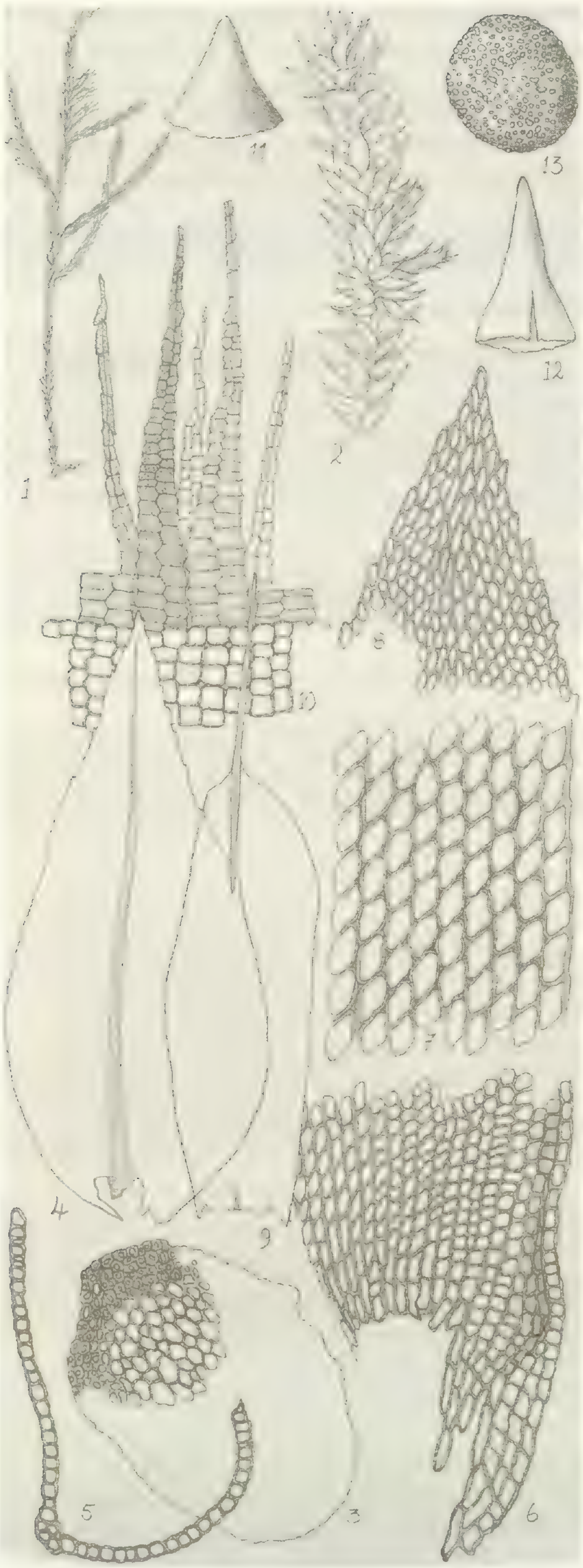
The peristome movement of *Cryphaea* is opposite that generally encountered in mosses. While most mosses have peristome teeth erect or reflexed when dry to facilitate spore dispersal by wind, the peristome of *Cryphaea* is closed when dry and open when wet. The advantage to *Cryphaea* is uncertain, but appears to be connected to the corticolous nature of the plants.

Cryphaea exigua *(C. Müll.) Jaeg.* in Ber. Thätigk. St. Gallischen Naturwiss. Ges. 1874–1875: 179 (1876); Broth. in Natürl. PflFam., edn 2, 11: 79 (1925); Sim, Bryo. S. Afr. 356 (1926). Type: South Africa, Cape, Philipstown, *s.l.* & *s.n.* (Herb. Gottschean).

Pilotrichum exiguum C. Müll., Syn. musc. frond. 2: 166 (1851).

Cryphaea dentata Mitt. in J. Linn. Soc., Bot. 22: 311 (1886). Type: South Africa, Natal, Umgoye Mt, *Plant s.n.* (NY).

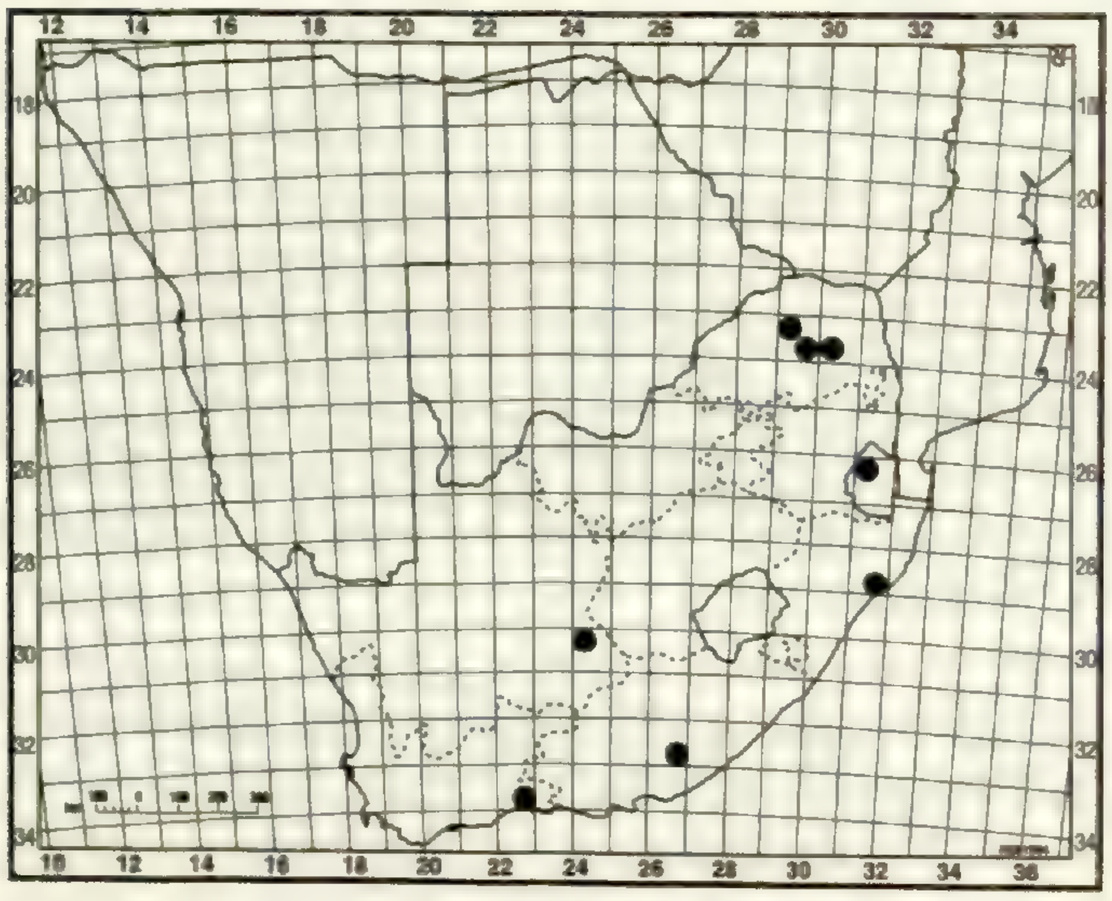
Plants medium-sized, scattered or gregarious, green to yellow-green; corticolous. *Primary stems* creeping; secondary stems erect (perpendicular to substrate), julaceous, up to 60 mm long, branching regular, pinnate; in section round, central strand absent, inner cortical cells large, thin-walled, hyaline, in 4 or 5 rows, outer cortical cells smaller, thick-walled, yellow, in 2 or 3 rows; axillary hairs short, basal cells differentiated, brownish; paraphyllia absent; pseudo-



paraphyllia sparse, short and filamentous. *Leaves* crowded, widespreading wet, loosely appressed dry; ovate to lanceolate, 1.6–2.6 mm long; acuminate; rounded and narrowed to insertion, decurrent; margins plane, almost entire to serrate above. *Costa* single, ending in acumen or subpercurrent, smooth; ventral surface smooth, cells elongate; dorsal surface smooth, cells elongate; in section subround, bulging dorsally, 2 or 3 rows of undifferentiated cells. *Upper laminal cells* rhombic or rounded, homogeneous, 12–25 µm long, 7–10 µm wide, walls weakly thickened, smooth; basal cells not strongly differentiated, linear, 30–40 µm long, 7–10 µm wide, walls weakly thickened, smooth; alar cells forming distinct groups, quadrate or transversely rectangular, walls weakly thickened.

Perigonia on stem, gemmate; leaves ovate-acuminate, to 1 mm long. *Perichaetia* strongly differentiated; leaves sheathing, oblong, abruptly aristate, 2–3 mm long; leaf cells linear-fusiform, weakly thickened. *Seta* 0.2 mm long, whitish, smooth. *Capsule* immersed but visible through perichaetial leaf awns, erect, cylindrical, up to 1.5 mm long, smooth, brown; neck not differentiated; exothecial cells somewhat irregular, quadrate to short rectangular, walls thin, deteriorating below with age, cells at mouth darker, quadrate; neck cells not differentiated; annulus present, vesiculose; stomata absent. *Peristome* white to yellowish; exostome teeth narrowly triangular, incurved and sigmoid dry, recurved wet, papillose, 320–350 µm high; endostome segments linear, almost as long as teeth, papillose, basal membrane absent, cilia absent. *Operculum* conical, erect, 0.4 mm long. *Calyptra* campanulate and split along one side, 0.5–0.7 mm long, smooth. *Spores* rounded, 22–31 µm, granulate, light brown. Fig. 153.

FIG. 153.—**Cryphaea exigua**: **1.** habit (dry), × 1; **2.** upper part of secondary stem (wet), × 3; **3.** stem in cross section, × 175; **4.** leaf, × 35; **5.** leaf in cross section, × 175; **6.** basal leaf cells, × 175; **7.** upper laminal cells at right margin, × 350; **8.** leaf apex, × 175; **9.** perichaetial leaf, × 35; **10.** part of capsule mouth with peristome (papillae partly shown), × 175; **11.** operculum, × 35; **12.** calyptra, × 35; **13.** spore, × 700. (1, 2, 5–7 & 11–13, *Crosby 7931*; 3, 4, 8 & 10, *Magill 3758*; 9, *Brenan 3270*.)



MAP 214.—**Cryphaea exigua**

Endemic to Africa, *C. exigua* is known from eastern and southern Africa. In the *Flora* area it is found on small trees in dry forests of the northern Transvaal area, Swaziland, Zululand, and the eastern, southern and central Cape regions. Map 214.

Vouchers: *Brenan 3270; Crosby & Crosby 7931, 8066; Magill 3412, 3764.*

Specimens of *Cryphaea exigua* can be identified by their habit, narrowly costate leaves with serrate margins, and numerous immersed capsules along erect stems. The leaf shape and marginal serrations also separate sterile specimens from mosses with similar growth forms, like *Forsstroemia* or *Leptodon* (see p. 585).

LEUCODONTACEAE

Plants small to large, forming loose tufts, green to yellow-green or brownish; saxicolous or corticolous. *Secondary stems* erect, julaceous dry, variably branched; in section central strand present or absent; paraphyllia absent; pseudoparaphyllia present or absent. *Leaves* appressed dry, widespreading wet; broadly ovate to elliptical; acute to acuminate; margins plain, entire or serrate. *Costa* absent, short and double, or single extending to above midleaf. *Upper laminal cells* short, rhombic to fusiform, smooth or prorate; basal cells elongate; alar cells in large groups, quadrate to transversely rectangular.

Dioicous. *Perichaetia* along stem, obvious. *Seta* short or long. *Capsule* generally exserted, short-cylindrical. *Peristome* double; exostome teeth somewhat irregular, linear, whitish, papillose or smooth; endostome rudimentary, frequently only basal membrane present. *Operculum* rostrate. *Calyptra* cucullate, smooth or with a few hairs. *Spores* granulate.

Leucodontaceae is a family of eight genera found in woodlands and forests throughout the Americas, Europe, Africa and parts of Asia. Much has been written in recent years about the relationships between Leucodontaceae and Cryphaeaceae, but consensus has not been reached as to the proper division of genera between the families. The families are divided in the *Flora* on the basis of calyptra development, capsule exsertion and costa type. *Forsstroemia* has been placed in both families, but in this treatment it is moved to the Leptodontaceae (see p. 585).

Leaves ecostate; margins entire; leaf cell smooth . . . . . 1. **Leucodon**
Leaves costate; upper leaf margins serrate; some upper leaf cells prorate on dorsal surface . . . . . 2. **Pterogonium**

1. LEUCODON

Leucodon *Schwaegr.*, Sp. musc. frond. suppl. 1,2: 1 (1816); Broth. in Natürl. PflFam., edn 2, 11: 91 (1925); Sim, Bryo. S. Afr. 357 (1926); Gangulee, Moss. E. India 5: 1218 (1976). Type species: *L. sciuroides* (Hedw.) Schwaegr.

Plants large, full or slender, in extensive loose tufts, green to yellow-green; saxicolous or corticolous. *Stems* little-branched, julaceous. *Leaves* generally appressed dry, widespreading wet; margins plain, entire. *Costa* variable or absent. *Laminal cells* short, thickened, usually smooth; basal cells forming distinct group in lower leaf; alar cells quadrate, forming large distinct groups.

Perichaetia along stem, obvious. *Seta* long. *Capsule* exserted, short-cylindrical. *Peristome* double. *Operculum* rostrate. *Calyptra* cucullate, smooth. *Spores* large.

Leucodon is a genus of 33 species found in the Americas, Europe, Africa and northern Asia. A large number of species have been described from Asia, but the genus has not been reported from the East Indies, Australia or New Zealand.

The southern African species is distinct from other members of the genus by its complete lack of a central strand in the stem (see Manuel 1974). The absence of a costa and smooth rather than prorate upper leaf cells are also notable characters in the southern African species, although these conditions are found in other species as well.

Leucodon assimilis *(C. Müll.) Jaeg.* in Ber. Thätigk. St. Gallischen Naturwiss. Ges. 1875–1876: 217 (1877); Broth. in Natürl. PflFam., edn 2, 11: 92 (1925); Sim, Bryo. S. Afr. 358 (1926). Syntypes: South Africa, Grootvadersbosch, *Pappe s.n.*; Adoi, Uitenhagen District, *Ecklon s.n.*

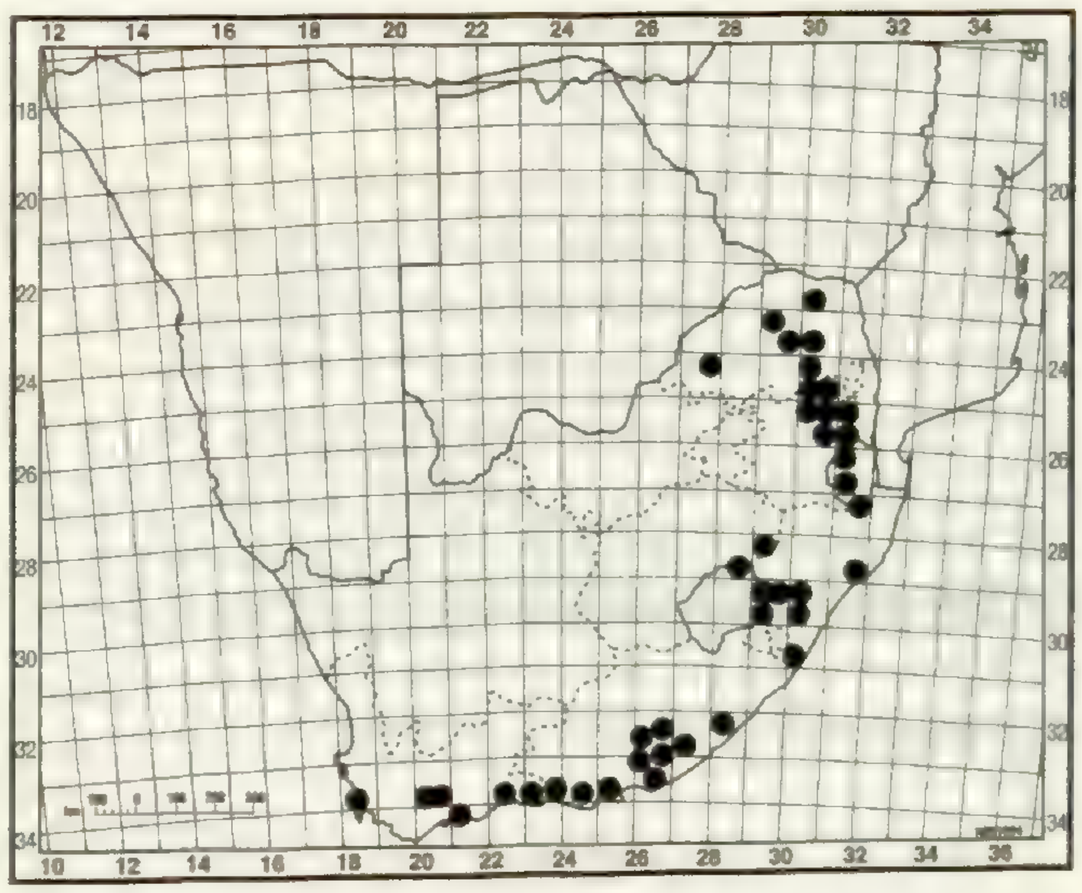
Neckera assimilis C. Müll., Syn. musc. frond. 2: 92 (1850).

Leucodon capensis Schimp. in Ren., Prodr. fl. bryol. Madagascar 184 (1898). Syntypes: La Réunion, Cilaos, *Eudel*; Madagascar, Ambatomanga, *Talazac*, 1894 (PC).

Braunia elliottii Broth. in Bot. Jahrb. Syst. 24: 253 (1897). Type: East Africa, Shire Highlands, Sotchi, *Elliott s.n.*

Braunia peristomata Dix. in S. African J. Sci. 18: 324 (1922). Syntypes: Zimbabwe, Zimbabwe Ruins, *Sim 8750, 8778, 8793, 8809*; Fort Victoria, *Sim 8843* (BM, PRE).

Leucodon assimilis var. *humilis* Sim, Bryo. S. Afr. 358 (1926). Type: South Africa, Transvaal, Houtbosch, *Rehmann 605* (PRE).



MAP 215.—**Leucodon assimilis**

Plants medium to large, full or slender, forming extensive, loose tufts, green to yellow-green or brownish; corticolous or saxicolous. *Primary stems* creeping; secondary stems ± erect, julaceous, ± curved when dry, 40–100 mm long, branching sparse, irregular; in section round, central strand absent, inner cortical cells large, thin-walled, hyaline, in 6–8 rows, outer cortical cells smaller, thick-walled, yellowish red; paraphyllia absent; pseudoparaphyllia absent. *Leaves* crowded, ecostate, widespreading wet, appressed or occasionally spreading dry; stem leaves ovate to elliptical, 1.2–2.5 mm long; abruptly short-acuminate or acute; rounded and narrowed to insertion; margins plane, entire. *Upper laminal cells* rhombic or some fusiform, homogeneous, 10–25(–34) µm long, 3–6 µm wide, walls thickened, frequently strongly so, smooth; basal cells forming distinct group near centre of leaf, confined to lower leaf or occasionally partly extending to above midleaf, linear, 50–90 µm long, 4–6 µm wide, yellowish, walls incrassate and pitted, smooth; alar cells forming distinct groups, quadrate to transversely rectangular, extending to midleaf, green, walls weakly thickened.

Perigonia on stem, gemmate. *Perichaetia* along stem, obvious; perichaetial leaves imbricate, oblong to lanceolate 3–5 mm long, apex acute, leaf cells linear. *Seta* 6–12 mm long, yellow-brown, smooth. *Capsule* exserted, erect, short-cylindrical to ovoid, 2.0–2.5 mm long, smooth, yellow-brown; neck not differentiated; exothecial cells irregular, quadrate to rectangular, walls thin, cells at mouth darker, quadrate; annulus absent; stomata on lower urn, phaneropore. *Peristome* double, whitish to yellowish with age; exostome teeth irregular, lanceolate, papillose, cleft and perforated, 200–250 µm high; endostome segments absent, basal membrane rudimentary, papillose, cilia absent. *Operculum* curved-rostrate, 1 mm long. *Calyptra* cucullate, 5 mm long, smooth. *Spores* rounded, 25–30 µm, granulate, brownish. Fig. 154: 1–12.

Found on rock and trees, *Leucodon assimilis* is known from central, eastern and southern Africa and the East African islands. In the *Flora* area specimens were collected in forests of the northern, central and eastern Transvaal regions, Swaziland, Zululand, KwaZulu-Natal, eastern Free State, and the eastern, southern and south-western Cape. Map 215.

FIG. 154.—**Leucodon assimilis** (1–12): **1.** habit (dry), × 1; **2.** habit (wet), × 3; **3.** part of stem in cross section, × 175; **4.** leaf, × 32; **5.** leaf in cross section, × 175; **6.** basal leaf cells (left side), × 175; **7.** upper laminal cells, × 350; **8.** cells at leaf apex, × 175; **9.** perichaetial leaf, × 35; **10.** part of capsule mouth with peristome (papillae partly shown), × 175; **11.** operculum, × 32; **12.** spore, × 700. **Pterogonium gracile** (13–22): **13.** habit (dry), × 1; **14.** habit (wet), × 3; **15.** part of stem in cross section, × 160; **16.** stem leaf, × 32; **17.** branch leaf, × 35; **18.** branch leaf in proximal cross section, × 175; **19.** branch leaf in distal cross section, × 175; **20.** basal cells of branch leaf, × 175; **21.** upper laminal cells of branch leaf, × 320; **22.** branch leaf apex, × 160. (1, *Magill 3768*; 2–7 & 9–12, *Magill 3701*; 8, *Magill 3271*; 13 & 14, 17–20, *Magill 3216*; 15, 16, & 21, *Esterhuysen 24670*.)

Vouchers: *Crosby & Crosby 8036; Ellis 3091; Kemp 744; Magill 3701, 6511; Schelpe 7874.*

This species is most easily recognized when it forms large, loose tufts on boulders or tree limbs. The julaceous stems are ± erect and have few branches. The leaves are ecostate, but have a pronounced group of elongated basal cells in the lower centre of the leaf. *Leucodon assimilis* is similar to the North American species, *L. julaceus* (Hedw.) Sull. which differs by having the upper laminal cells papillose on the dorsal surface. Specimens of *L. assimilis* are frequently confused with *Braunia secunda* (p. 547). However, that species has weakly plicate leaves, generally hyaline and papillose leaf tips, and gymnostomous capsules.

Specimens of the var. *humilis* described by Sim have a distinctive habit, their leaves remaining widespreading when dry, rather than becoming appressed. No other characters were found that would support recognition of the variety; both expressions are occasionally present in single collections.

2. PTEROGONIUM

Pterogonium *Sw.* in Monthly Rev. 2, 34: 537 (1801); Broth. in Natürl. PflFam., edn 2, 11: 98 (1925); Sim, Bryo. S. Afr. 360 (1926); Smith, Moss Fl. Brit. Irel. 503 (1978). Type species: *P. gracile* (Hedw.) Sm.

Plants medium-sized, forming loose tufts, yellow-green; saxicolous or corticolous. *Secondary stems* erect from creeping primary stems, densely branched, stems and branches curved when dry; central strand present. *Leaves* ovate; margins serrulate. *Costa* short and double. *Laminal cells* short, thickened, sparsely prorate on upper dorsal surface; basal cells elongate; alar cells differentiated.

Sporophyte not known from *Flora* area but described as dioicous. *Perichaetial leaves* long-sheathing. *Capsule* exserted, ellipsoidal. *Peristome* double; exostome teeth papillose-striate below; endostome segments short above basal membrane, cilia absent. *Operculum* conical. *Calyptra* cucullate, with a few hairs. *Spores* small, 14–20 µm.

A genus of three species, *Pterogonium* is found in the Americas, Europe and Africa. A single species, *P. gracile* with several regional varieties, is known from throughout Africa and the African islands. The genus is recognized by its distinct branching pattern and curved stems and branches when dry.

Pterogonium gracile *(Hedw.) Sm.*, Engl. bot. 16: 1085 (1802); Dixon, Stud. handb. Brit. mosses, edn 3: 404 (1924); Lawton, Moss Fl. Pacific Northwest 240 (1971). Type: England and Scotland.

Pterigynandrum gracile Hedw., Sp. musc. frond. 80 (1801). *Anomodon gracilis* (Hedw.) Garov., Bryol. austr. excurs. 46 (1840). *Neckera gracilis* (Hedw.) C. Müll., Syn. musc. frond. 2: 97 (1850).

Grimmia ornithopodioides Web. & Mohr, Bot. Taschenb. 148 (1807). *Pterogonium ornithopodioides* (Web. & Mohr) Lindb. in Ofvers. Forh. Kongl. Svenska Vetensk.-Akad. 20: 411 (1863); Broth. in Natürl. PflFam., edn 2, 11: 99 (1925); Sim, Bryo. S. Afr. 360 (1926). Type: Europe.

Pterogonium gracile var. *capense* C. Müll. ex Dix., Stud. handb. Brit. mosses, edn 3: 405 (1924).

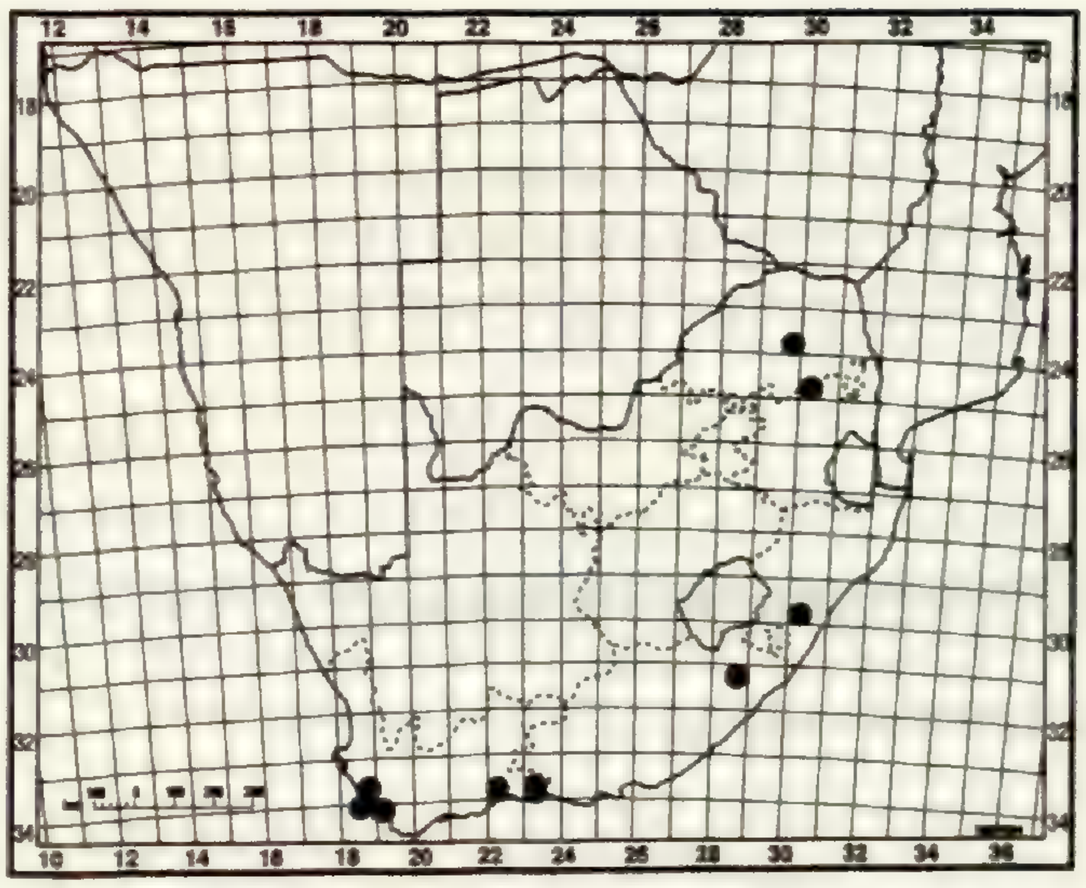
Forsstroemia dendroides Dix. in Sim, Bryo. S. Afr. 360 (1926), nom. nud.

Plants small to medium-sized, forming loose tufts, yellow-green to glaucous green; corticolous or saxicolous. *Primary stems* creeping, naked; secondary stems erect, 15–35 mm long; branching dense above stipe, subdendroid, fasciculate to pinnate, rarely flagellate, distinctly curved when dry; in section oval, central strand small, inner cortical cells thin-walled, yellow, in stipe 8–10 rows wide, 5 or 6 rows in branches, outer cortical cells smaller, thick-walled, yel-

low-brown, in stipe 6–8 rows wide, 3 or 4 rows in branches; paraphyllia absent; pseudoparaphyllia absent. *Leaves* crowded, erect-spreading wet, appressed dry; leaves on stipe broadly ovate, 1.0–1.5 mm long; acute; rounded at base; margins plane, weakly serrulate; branch leaves ovate to elliptical, 1.2–2.2 mm long; acute; rounded to cordate at base; margins plane, serrate. *Costa* short and double, occasionally broad at insertion and with 2–4 short spikes; in section flat, consisting of 3 rows of undifferentiated cells. *Upper laminal cells* short-fusiform to rhomboidal, somewhat sigmoid, homogeneous, 12–25 µm long, 7–8 µm wide, walls thickened, with a few sharply prorate cells on upper dorsal surface; basal cells oblong to linear juxtacostally, forming distinct groups, irregularly quadrate to transversely rectangular, green, walls thickened; alar cells in distinct group, quadrate.

Sporophyte not known in *Flora* area. Fig. 154: 13–22.

Pterogonium gracile, found in eastern Africa and the East African islands, Macaronesia, Europe, the Middle East and western North America, forms large tufts on boulders or on the base of trees. In southern Africa the species is found in the northern and eastern Transvaal areas, KwaZulu-Natal, and the eastern, southern and southwestern Cape. Map 216.



MAP 216.—**Pterogonium gracile**

Vouchers: *Crosby & Crosby 9199; Esterhuysen 19186; Magill 3287; Van Rooy 2280.*

When dry the stems and branches are curved, giving the plants a distinctive appearance. The serrate upper leaves, short and double costa and strongly differentiated alar cells help to identify specimens of *P. gracile*.

The branch leaves have a few scattered prorate cells on the upper dorsal surface. The papillae are obvious, even at lower magnifications, in micropreparations and should also aid in identifications.

PRIONODONTACEAE

The family Prionodontaceae contains two genera that are found in tropical and south temperate regions of the Americas, Africa and Asia. Only one of the genera, *Prionodon*, is known from forests of western, eastern and southern Africa and Madagascar.

PRIONODON

Prionodon *C. Müll.* in Bot. Zeitung (Berlin) 2: 129 (1844); Broth. in Natürl. PflFam., edn 2, 11: 112 (1925); Sim, Bryo. S. Afr. 356 (1926); Griffin in Rickia 6: 9 (1974). Type species: *P. densus* (Hedw.) C. Müll.

Plants mostly robust, green, forming large, loose tufts; corticolous. *Secondary stems* ± erect, simple or branched; central strand absent. *Leaves* fragile, ovate-lanceolate, coarsely toothed above. *Costa* single, strong, extending to upper leaf. *Laminal cells* oval, incrassate, unipapillose; alar cells differentiated.

Dioicous. *Perichaetia* along secondary stems. *Sporophytes* rare. *Seta* short. *Capsule* exserted, erect. *Peristome* double. *Operculum* obliquely rostrate. *Calyptra* cucullate, smooth.

A genus of 26 species found in forests of tropical and south temperate regions. The plants form large, loose tufts on trees. The genus is apparently represented in Africa by a single variable species, *P. densus*.

Prionodon densus *(Hedw.) C. Müll.* in Bot. Zeitung (Berlin) 2: 129 (1844); Broth. in Natürl. PflFam., edn 2, 11: 114 (1925); Bartram in Fieldiana, Bot. 25: 245 (1949). Type: Jamaica.

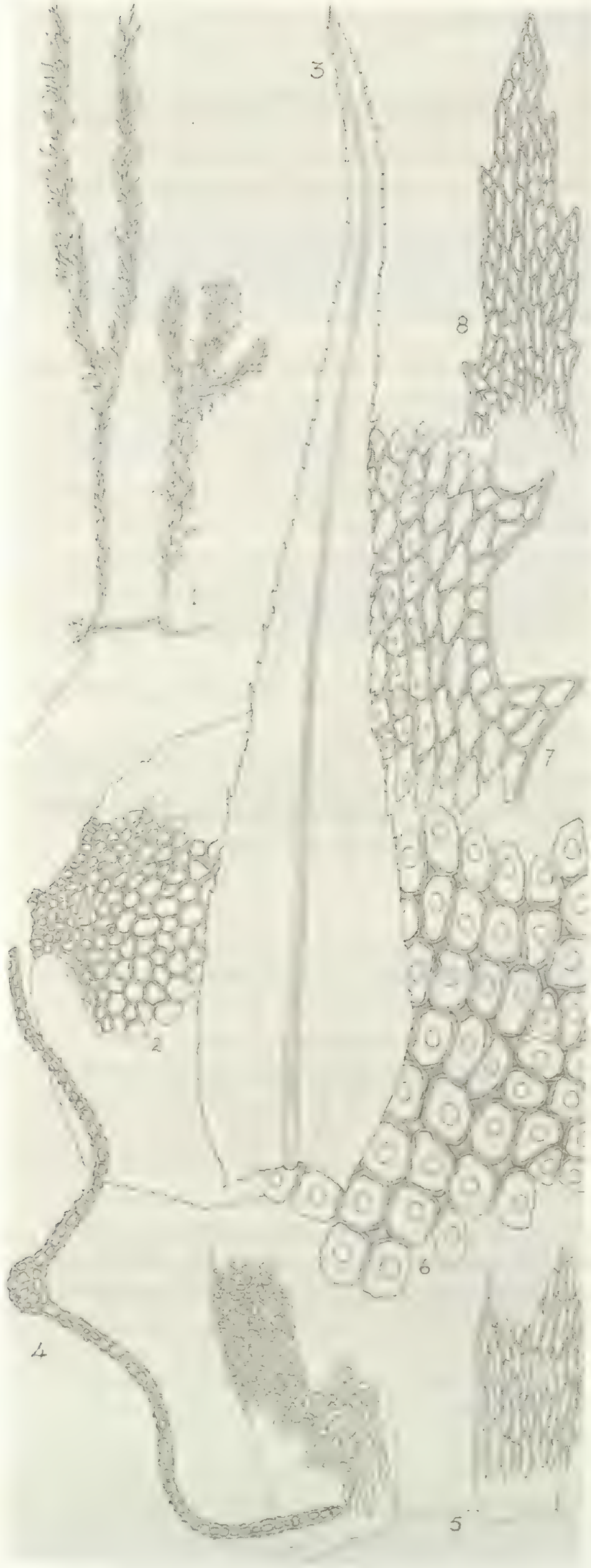
Hypnum densum Sw. ex Hedw., Sp. musc. frond. 282 (1801).

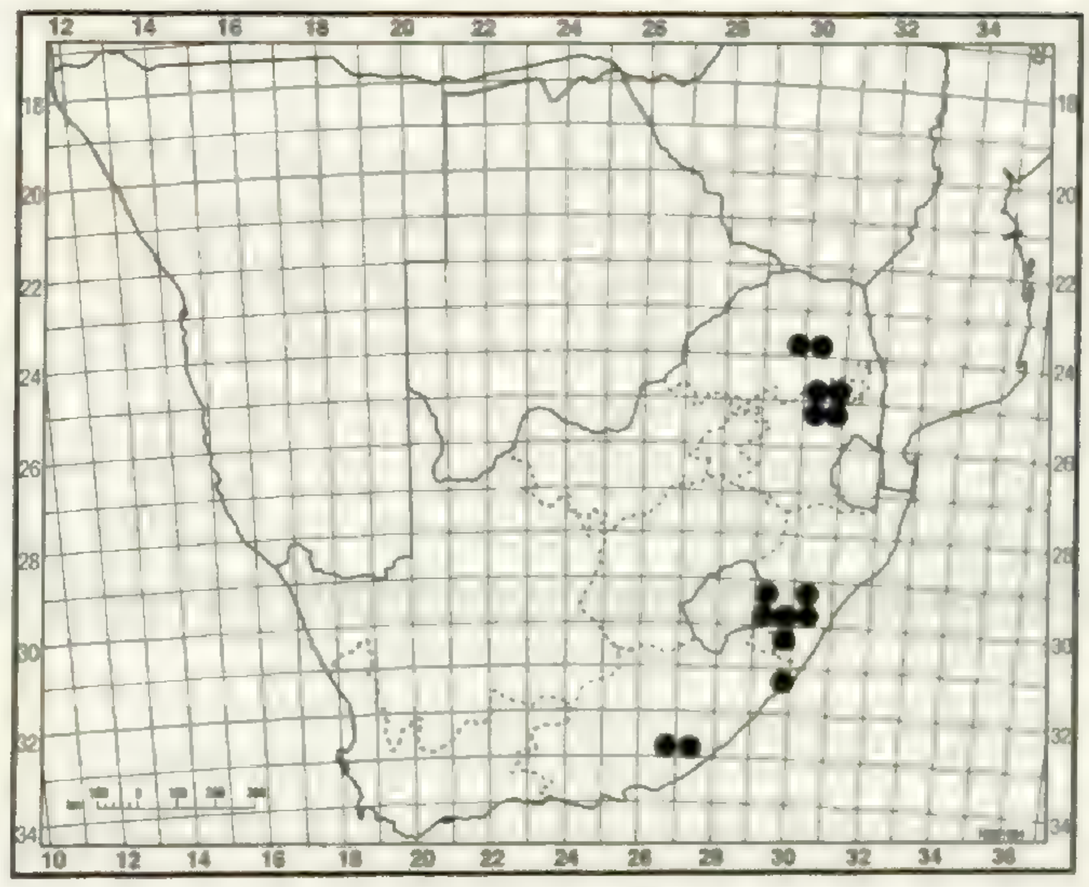
Prionodon rehmannii Mitt. in J. Linn. Soc., Bot. 22: 311 (1886); Broth. in Natürl. PflFam., edn 2, 11: 114 (1925); Sim, Bryo. S. Afr. 356 (1926). Syntypes: Kilimanjaro, *Hannington s.n.*; Transvaal, *Rehmann s.n.* (BM, PRE).

Plants large to robust, loosely tufted, yellow-green; corticolous. *Primary stems* creeping, tomentose; secondary stems erect, (40–) 70–130 mm long, branches few, scattered; in section oval, central strand absent, inner cortical cells thin-walled, hyaline to yellowish, in 8–10 rows, outer cortical cells thick-walled, yellow to yellow-brown, in 2–4 rows; axillary hairs with basal cells brownish, 3 or 4 cells high; paraphyllia absent; pseudoparaphyllia folious, low and wide. *Leaves* crowded, erect to spreading wet, spreading and crisped dry, strongly plicate; ovate to lanceolate, 3.5–5.5 mm long; apex long-acuminate, fragile and missing on older leaves; long-decurrent at base; margins plane, dentate to spinose. *Costa* single, percurrent to ending below apex, smooth; ventral and dorsal surface cells elongate; in section bulging dorsally, guide cells somewhat larger, ventral cells small, thick-walled, in 1 or 2 rows, dorsal cells thick-walled, in 3 or 4 rows. *Upper laminal cells* oval, quadrate or rhombic, ± homogeneous, 25–50 µm long, 15–22 µm wide, walls incrassate, weakly papillose on both surfaces; papillae single, low, centred over lumen; marginal cells frequently not papillose; basal cells rectangular, 50–100 µm long, 12–20 µm wide, hyaline, walls incrassate, pitted, smooth; alar cells quadrate to hexagonal, forming distinct groups, greenish, walls incrassate, nodulose.

Perigonia not seen. *Perichaetia* not strongly differentiated, perichaetial leaves lanceolate-acuminate when young. *Capsule* not known from Africa. Fig. 155.

The extremely variable and usually sterile species *P. densus* is thought to be the most





MAP 217.—**Prionodon densus**

commonly collected species of *Prionodon* throughout its range. It is found in Central and South America, eastern Africa and the East Arican islands and is probably the only species in Africa. In the *Flora* area it is found on trees in forests of the northern and eastern Transvaal regions, KwaZulu-Natal, and the eastern Cape. Map 217.

Vouchers: *Brenan 3343; Crosby & Crosby 9929; Jacot Guillarmod 6136, 8117.*

This species is recognized by its large, little-branched secondary stems and narrow, coarsely toothed, plicate leaves. The leaf tips are very fragile and absent on most older leaves. The leaf cells are short, oval to rhombic and unipapillose on both surfaces. *Prionodon* could perhaps be confused with several genera of the Pterobryaceae that have a similar habit, but these genera all have smooth leaf cells and filamentous pseudoparaphyllia.

FIG. 155.—**Prionodon densus**: **1.** habit (dry), × 1; **2.** part of stem in cross section, × 175; **3.** leaf, × 32; **4.** leaf in cross section, × 175; **5.** leaf base (cells partly shown), × 160; **6.** upper laminal cells, × 700; **7.** upper laminal cells at right margin, × 350; **8.** leaf apex, × 175. (1, 3 & 5–8, *Crosby 7531*; 2 & 4, *Knox 28*.)

TRACHYPODACEAE

Plants small to large, forming mats and frequently with long-pendent branches, green to yellow-green or yellow-brown, blackish below; corticolous or saxicolous. *Stems* long-creeping, irregularly branched to pinnate; central strand weak or absent. Paraphyllia and pseudoparaphyllia absent. *Leaves* appressed or spreading, rarely curved, sometimes longitudinally plicate; broadly ovate to lanceolate; apex long- or short-acuminate, frequently crisped; margins plane, almost entire to strongly toothed, rounded to weakly auriculate at base. *Costa* single, extending to above midleaf or ending in acumen. *Laminal cells* homogeneous, linear to fusiform, rarely isodiametric, unipapillate or seriately papillose over lumens, cell walls thickened; basal cells longer, thickened and pitted; alar cells not strongly differentiated.

Dioicous. *Perigonia* on stems and branches, gemmate. *Perichaetia* lateral on stems and branches. *Seta* erect, 2–50 mm long, smooth to strongly papillose. *Capsule* erect to inclined, mostly oblong-cylindrical, up to 3 mm long. *Peristome* double; exostome teeth yellowish, lanceolate with median zigzag line, striate below, papillose above; endostome segments short or as long as teeth above high or low basal membrane, smooth or papillose, cilia present or absent. *Operculum* conical, obliquely rostrate. *Calyptra* cucullate or mitrate, smooth or hairy. *Spores* small, rounded, papillose.

A family of six genera found primarily in southeast Asia. A few taxa extend as far north as Japan or to the south as far as Australia, South Africa and southern Brazil. The family is best represented in the tropical forests of Asia but is also known from forests of India, Africa and the East African islands, South America, Central America and the larger Caribbean Islands.

Leaves crisped at apex when dry; laminal cells with a single papilla over each cell . . . . . 1. **Trachypodopsis**
Leaves weakly plicate, not distinctly crisped at apex; laminal cells seriate papillose with several low, blunt papillae over each cell . . . . . 2. **Trachypus**

1. TRACHYPODOPSIS

Trachypodopsis *Fleisch.* in Hedwigia 45: 64 (1906); Broth. in Natürl. PflFam., edn 2, 11: 120 (1925); Sim, Bryo. S. Afr. 397 (1926); Van Zanten in Blumea 9: 511 (1959). Lectotype species: *T. serrulata* (P. Beauv.) Fleisch., vide Van Zanten (1959).

Plants large, forming mats with pendent branches, green to yellow-green or brownish, not blackened; corticolous or saxicolous. *Primary stems* long-creeping; secondary stems and branches frequently pendent; central strand present or absent. *Leaves* appressed and horizontally spreading, crisped at apex; margins toothed. *Costa* single and slender, extending to upper leaf. *Laminal cells* linear-fusiform, incrassate and pitted, papillose with a single papilla over each lumen; alar cells not differentiated.

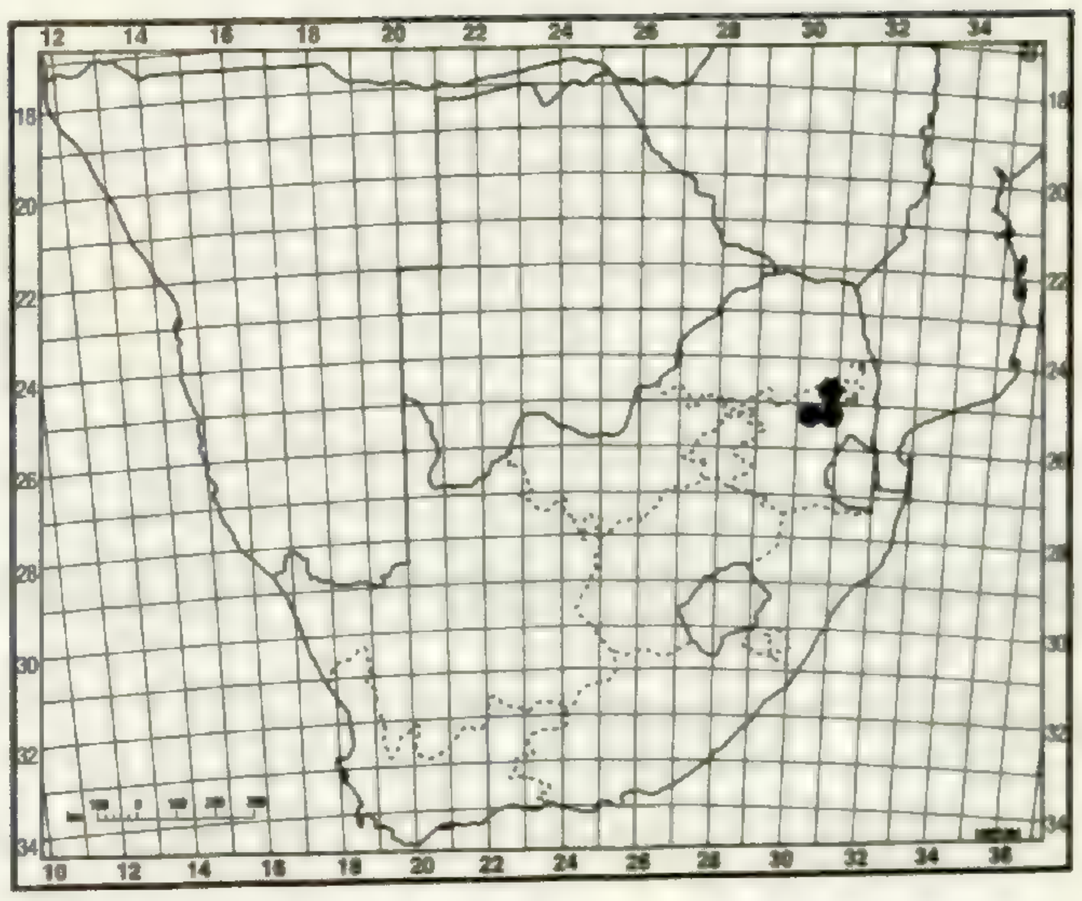
Dioicous. *Seta* erect, short, papillose. *Capsule* exserted, erect, ovoid. *Peristome* double, cilia absent. *Operculum* obliquely rostrate. *Calyptra* cucullate. *Spores* small, yellowish, papillose.

Trachypodopsis contains five species found primarily in Asia. The genus is also known from Africa and Central America as different varieties of the widespread species *T. serrulata*. In Africa the typical variety is found in forests of eastern, western and southern Africa and the East African islands.

Trachypodopsis serrulata *(P. Beauv.) Fleisch.* in Hedwigia 45: 67 (1906); Broth. in Natürl. PflFam., edn 2, 11: 122 (1925); Sim, Bryo. S. Afr. 397 (1926); Van Zanten in Blumea 9: 517 (1959). Type: Mascarene islands, Bourbon, *Bory St. Vincent* (L).

Pilotrichum serrulatum P. Beauv., Prodr. aethéogam. 83 (1805). *Neckera serrulata* (P. Beauv.) Brid., Muscol. recent. suppl. 2: 29 (1812). *Papillaria serrulata* (P. Beauv.) Jaeg. in Ber. Thätigk. St. Gallischen Naturwiss. Ges. 1875–1876: 274 (1877). *Trachypus serrulatus* (P. Beauv.) Besch. in Ann. Sci. Nat. Bot. 6, 10: 269 (1880).

Neckera macleana Rehm. in Par., Index bryol. 852 (1896), nom. nud.; Sim, Bryo. S. Afr. 397 (1926).



MAP 218.—**Trachypodopsis serrulata**

Plants large, forming mats or somewhat pendent, green or yellow-green to brownish; saxicolous. *Stems* creeping or pendent, 20–100 mm long, branching irregular, branches ± pinnate; in section round, central strand small, inner cortical cells somewhat thick-walled, hyaline, in 7 or 8 rows, outer cortical cells smaller, thick-walled, yellow-brown, in 3 or 4 rows; axillary hairs few, hyaline, 3 or 4 cells long; paraphyllia absent; pseudoparaphyllia absent but bud loose with erect, reduced leaves. *Leaves* evenly spaced, complanate, spreading to horizontal wet, appressed dry; oblong to broadly ovate, 2.0–3.5 mm long; short- to long-acuminate; apex contorted especially when dry; rounded or weakly auriculate at base; margins plane, denticulate to dentate, some teeth recurved, cells not differentiated but somewhat longer. *Costa* single, ending in acumen, smooth, surface cells elongate, smooth; in section elliptical, guide cells 2, large, thin-walled, dorsal and ventral cells in single row, smaller, thickened. *Upper laminal cells* linear to fusiform, homogeneous, 25–37 µm long, 3–7 µm wide, walls incrassate and pitted, papillose, papillae single, centred over lumen; basal cells oblong-hexagonal, 25–50 µm long, 7–10 µm wide, yellow, walls incrassate and pitted, smooth; alar cells rounded, quadrate to rectangular, hyaline, walls ± thickened and pitted.

Perigonia on stem and branches, gemmate; leaves ovate-acuminate, up to 1 mm long. *Perichaetia* and sporophyte not seen. Fig. 156: 1–8.

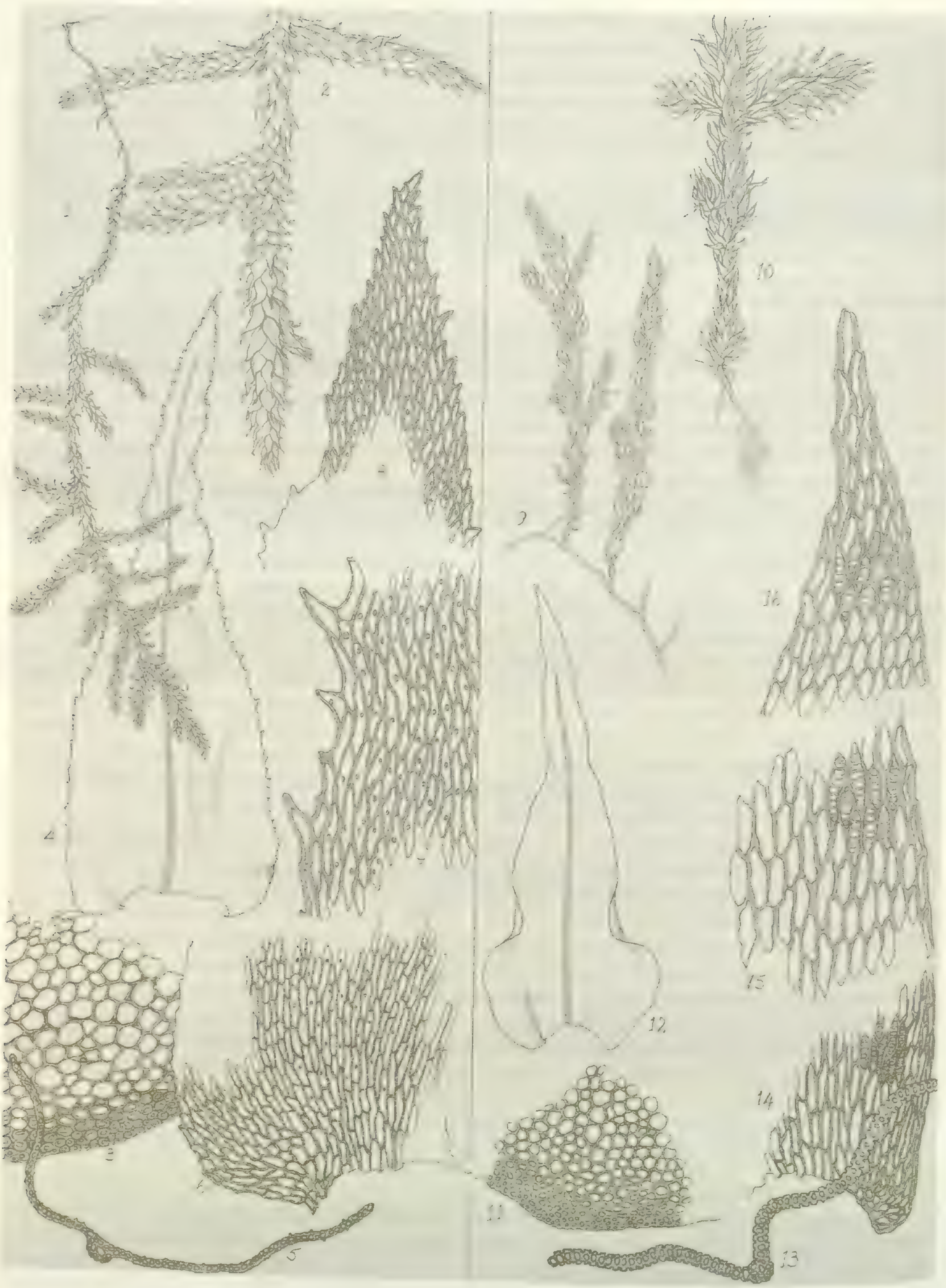
The typical variety of *T. serrulata* is found infrequently in forests of eastern, western and southern Africa, the East and West African islands and India (Assam). In the *Flora* area it forms mats on rocks and trees in forests of the eastern Transvaal region. Map 218.

Vouchers: *Crosby & Crosby 13374; Kluge 2003; Smook & Phelan 846; Raven 26218.*

The species is easily recognized by its appressed and horizontally spreading leaves and crisped leaf apex when dry. In addition the leaf cells have a single, small papilla centred over the lumen. This feature is also known in *Aerobryopsis capensis*, but the leaves of that species are widely spreading and lack the crisped apex of *Trachypodopsis*.

2. TRACHYPUS

Trachypus *Reinw. & Hornsch.* in Nova Acta Phys.-Med. Acad. Caes. Leop.-Carol. Nat. Cur. 14: 708 (1829); Broth. in Natürl. PflFam., edn 2, 11: 118 (1925); Van Zanten in Blumea 9: 481 (1959). Type species: *T. bicolor* Reinw. & Hornsch.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Plants medium to large, forming lax mats, green to yellow-green or brownish, frequently blackish below; saxicolous or corticolous. *Primary stems* long-creeping; secondary stems erect, ascending or sometimes pendent; central strand absent. *Leaves* erect and contorted dry, spreading wet, lamina somewhat plicate, margins entire to serrate. *Costa* single, slender and extending to midleaf or above. *Laminal cells* fusiform, incrassate, seriate-papillose with several low, blunt papillae that cover lumen; alar cells not differentiated.

Dioicous. *Perigonia* and perichaetia along stems and branches; perichaetial leaves long-acuminate above sheathing base. *Seta* elongate, erect, papillose. *Capsule* exserted, ovoid. *Operculum* obliquely long-rostrate. *Calyptra* cucullate, hairy. *Spores* rounded, yellowish, papillose.

The genus *Trachypus* contains five species known primarily from India, southeast Asia and islands of the Pacific. Two varieties of the most widely distributed species, *T. bicolor*, are also known from Africa and tropical America.

Trachypus bicolor *Reinw. & Hornsch.* var. **viridulus** *(Mitt.) Zant.* in Blumea 9: 499 (1959). Type: Ecuador, near Quito, *Jameson s.n.*

Neckera viridula Mitt. in Hooker's J. Bot. Kew Gard. Misc. 3: 331 (1851). *Papillaria viridula* (Mitt.) Jaeg. in Ber. Thätigk. St. Gallischen Naturwiss. Ges. 1875–1876: 267 (1877). *Trachypus viridulus* (Mitt.) Broth. in Natürl. PflFam. 1,3: 831 (1906); Broth. in Natürl. PflFam., edn 2, 11: 119 (1925).

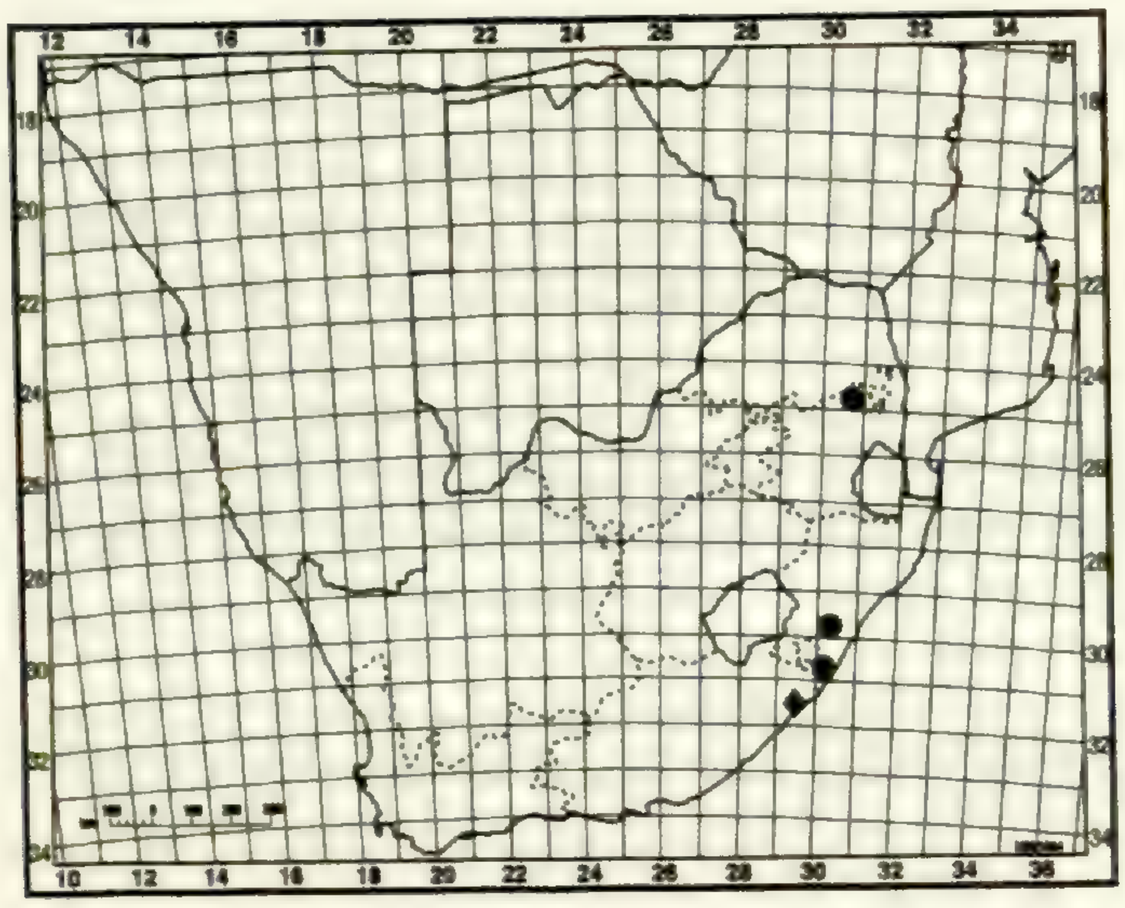
Papillaria natalensis Sim, Bryo. S. Afr. 392 (1926). Type: South Africa, Natal, Pietermaritzburg, Town Bush, *Sim 8703* (PRE).

Plants medium to large, forming mats, green to yellow-green, black below; terricolous or saxicolous. *Stems* creeping, up to 50 mm long, branches erect from creeping stem (perpendicular to substrate), pinnate; in section round, central strand absent, inner cortical cells weakly thick-walled, hyaline, in 4 or 5 rows, outer cortical cells smaller, thick-walled, yellowish, in 3 or 4 rows; axillary hairs not seen; paraphyllia absent; pseudoparaphyllia absent. *Leaves* ± crowded, spreading wet, erect-appressed and contorted dry, ± weakly plicate; ovate to lanceolate, 2 mm long; long-acuminate; weakly auriculate at base; margins plane, weakly serrulate. *Costa* single, extending to midleaf or above; ventral surface cells elongate, papillose; dorsal surface cells elongate, smooth; in section oblong, bulging dorsally, guide cells not differentiated, cells in 3 or 4 layers, dorsal cells smaller, strongly thickened. *Upper laminal cells* broadly fusiform, homogeneous, 27–37 µm long, 6–9 µm wide, walls thickened, papillose; papillae 8–10, low, seriate, centred over lumen and completely covering cells; basal cells rectangular, 25–50 µm long, 6–8 µm wide, hyaline, walls thickened and pitted, smooth at insertion; alar cells not differentiated.

Dioicous; sporophyte not known from *Flora* area. Fig. 156: 9–16.

Trachypus bicolor var. *viridulus* is found in forests of southern and southeastern Asia, India, Sri Lanka, eastern South Africa, the East and West African islands, Central America, northern South America, and the West Indies. In the *Flora* area the taxon is found on rocks and trees

FIG. 156.—**Trachypodopsis serrulata** (1–8): **1.** habit (dry), × 1; **2.** part of secondary stem, × 3; **3.** part of stem in cross section, × 175; **4.** leaf, × 35; **5.** leaf in cross section, × 175; **6.** basal leaf cells (left side), × 175; **7.** upper laminal cells at left margin, × 350; **8.** leaf apex, × 175. **Trachypus bicolor** var. **viridulus** (9–16): **9.** habit (dry), × 3; **10.** habit (wet), × 5; **11.** part of stem in cross section, × 175; **12.** leaf, × 35; **13.** leaf in cross section, × 175; **14.** basal leaf cells (papillae partly shown), × 200; **15.** upper laminal cells at right margin (papillae partly shown), × 350; **16.** cells at leaf apex (papillae partly shown), × 350. (1–8, *Kluge 2003*; 9, 11–14 & 16, *Rankin 157*; 10 & 15, *Hilliard & Burtt 10271*.)



MAP 219.— ● **Trachypus bicolor** var. **viridulus**
♦ **Jaegerina stolonifera**

in forests of the eastern Transvaal region and KwaZulu-Natal. Map 219.

Vouchers: *Burrows & Burrows 5984; Hilliard & Burtt 10271; Rankin 157.*

The blackish coloration of the older parts of stems and branches helps to identify the taxon, although a similar coloration is also frequently found in members of the Meteoriaceae. The low, blunt, seriate papillae on the leaf cells are distinctive and help to identify this species. *Trachypus bicolor* var. *hispidus* (C. Müll.) Card. and *T. appendiculatus* (Ren. & Card.) Broth. have been reported from eastern Africa but they are not clearly separated from the southern African taxon and many intermediate forms exist.

PTEROBRYACEAE

Plants small to large, occasionally robust, mostly dendroid, branches occasionally pendent, green to yellow-green or golden green; corticolous or saxicolous. *Primary stems* appressed to substrate, long-creeping, naked or with scale leaves; secondary stems erect, perpendicular to substrate, usually branched; in section central strand absent. *Leaves* erect and weakly crisped or squarrose dry, spreading to squarrose wet, generally strongly concave; broadly ovate to elliptical; rounded to cordate or auriculate at base; margins plane below, generally broadly inflexed above, entire to serrate. *Costa* variable. *Laminal cells* short to long, rhomboidal to fusiform or linear and sigmoid, generally thickened and pitted; basal cells rectangular, in yellowish band across insertion, thickened and pitted; alar cells generally differentiated, forming distinct group, usually quadrate, frequently thickened and pitted. *Gemmae* frequently present, cylindrical, multicellular, green or brown.

Mostly dioicous. *Perigonia* and perichaetia along secondary stem and branches, frequently large, green. *Seta* generally very short. *Capsule* mostly immersed. *Peristome* single or double, prostome frequently present; endostome usually rudimentary. *Operculum* conical to rostrate. *Calyptra* small, ephemeral, mostly smooth. *Spores* large, angular, papillose.

A family of 27 genera found in tropical and subtropical forests throughout the world. Seven genera are known from Africa, three extending into forests of southern Africa.

1 Leaves squarrose wet or dry . . . . . 1. **Jaegerina**
1 Leaves appressed to widely spreading:
2 Branches julaceous; leaves not noticeably seriate . . . . . 2. **Pterobryopsis**
2 Branch leaves spirally seriate . . . . . 3. **Orthostichopsis**

1. JAEGERINA

Jaegerina *C. Müll.* in Linnaea 40: 273 (1876); Broth. in Natürl. PflFam., edn 2, 11: 138 (1925); Argent in J. Bryol. 7: 367 (1973). Type species: *J. stolonifera* (C. Müll.) C. Müll.

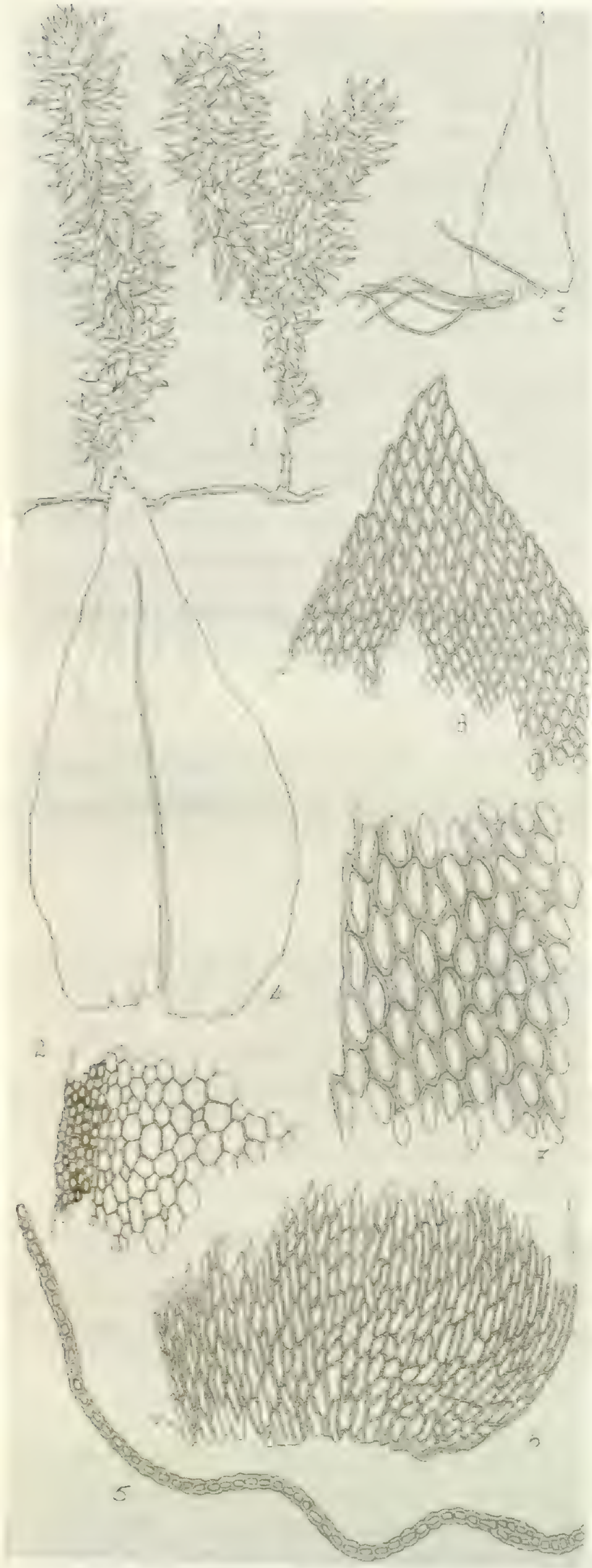
Plants large, green to yellow-green; corticolous. *Primary stems* creeping, with scale leaves; secondary stem erect, little branched; in section round, central strand absent. *Leaves* squarrose, somewhat plicate; broadly ovate; acute to acuminate; margins plane, serrulate; base cordate. *Costa* single, extending to upper leaf. *Laminal cells* short- to long-elliptical, thickened and pitted; basal and alar cells yellow but otherwise not strongly differentiated. *Gemmae* axillary, cylindrical.

Dioicous. *Seta* very short. *Capsule* immersed. *Peristome* single, exostome teeth broad. *Operculum* conical. *Calyptra* small. *Spores* large.

A small genus of about 13 species found in forests of the Americas, Africa and Asia. Two species are known from Africa and an additional four species are found on the East African islands.

Jaegerina stolonifera *(C. Müll.) C. Müll.* in Linnaea 40: 274 (1876); Argent in J. Bryol. 7: 369 (1973). Type: Comores, Anjouan, *Peters*, Oct. 1843.

Plants large, loose-tufted, yellow-green to brownish; corticolous. *Primary stems* long-creeping; secondary stems erect to subpendent, 20–50 mm long, branches few, rare; in section



oval, central strand absent, inner cortical cells thin-walled, hyaline, in up to 9 rows, outer cortical cells smaller, thick-walled, in 6–8 rows; paraphyllia absent; pseudoparaphyllia filamentous. *Leaves* evenly spaced, in ranks, squarrose wet or dry, weakly rugose; stem leaves broadly ovate or lanceolate, 2.5–5.5 mm long; narrowly acuminate; rounded to cordate at base; margins plane, serrulate. *Costa* single, ending in acumen, smooth; in section elliptical or flat, guide cells not differentiated, ventral cells in a single row, dorsal cells larger, in single row. *Upper laminal cells* elliptical, homogeneous, 10–35 µm long, 4–7 µm wide, walls thickened and pitted, smooth; basal cells linear, 50–75 µm long, 5–7 µm wide, yellowish to brownish, walls thickened and pitted, smooth; alar cells not strongly differentiated, short-rectangular, brownish, walls thickened and pitted. *Gemmae* scattered along stems, cylindrical to clavate, brownish, smooth.

Sporophyte not known from the *Flora* area. Fig. 157.

Apparently rare, this large species is only rarely collected in forests of eastern and southern Africa, the East African islands and India. Only a single specimen has been seen from the *Flora* area, collected in forests of the eastern Cape. Map 219.

Voucher: *Wager PRE-CH1456.*

Jaegerina stolonifera is very distinctive, both in its size and squarrose leaves. Since the species has not been recollected, the southern African specimen may represent a local chance introduction from the East African islands.

FIG. 157.—**Jaegerina stolonifera**: **1.** habit (dry), × 3; **2.** part of stem in cross section, × 175; **3.** scale leaf of primary stem, × 35; **4.** leaf of secondary stem, × 25; **5.** part of leaf in cross section, × 175; **6.** basal leaf cells (right side), × 175; **7.** upper laminal cells at left margin, × 350; **8.** leaf apex, × 175. (*Wager PRE-CH1456.*)

2. PTEROBRYOPSIS

Pterobryopsis *Fleisch.* in Hedwigia 45: 56 (1906); Broth. in Natürl. PflFam., edn 2, 11: 140 (1925). Lectotype species: *P. crassicaulis* (C. Müll.) Fleisch., fide Arzeni (1954).

Plants medium-sized to large, forming lax tufts, glossy, yellow-green to green; mostly terricolous. *Primary stems* long-creeping; secondary stems erect to short-pendent, irregularly to pinnately branched, densely leaved throughout; in section central strand absent. *Leaves* usually imbricate, strongly concave; broadly ovate to oval; acute to abruptly acuminate; subcordate to weakly auriculate at base. *Costa* absent, short and double, or single and extending to above midleaf. *Upper laminal cells* linear-fusiform to rhomboidal, usually strongly thickened and pitted; basal cells rhomboidal to rectangular, coloured across insertion; alar cells ± differentiated, smaller, quadrate. *Gemmae* axillary, cylindrical.

Dioicous. *Sporophytes* rare. *Seta* short, smooth. *Capsule* immersed, ovoid. *Peristome* irregular, smooth; prostome present. *Operculum* conic-rostrate. *Calyptra* small, ephemeral. *Spores* large, up to 50 µm.

Pterobryopsis is a genus of 43 species centred in southeast Asia and India. A few species are also known from the Americas, Africa and Australia. The generic distinctions between *Pterobryopsis* and *Calyptothecium* Mitt. have faded as more species have been discovered or moved into the genera. Although a completely satisfactory solution to the problem of separating the genera will not be found until they are monographed, a more restrictive view of *Calyptothecium* is adopted here and the southern African species are transferred to *Pterobryopsis*. When Mitten (1869) described *Calyptothecium*, the two obvious characters he used were the distichous branches and flattening of the leaves along the stem. These characters were also partly responsible for the positioning of the genus in Neckeraceae. In Africa three species have their stem leaves complanate, *C. bescherellei* (Ren.) Broth., *C. planifrons* (Ren. & Card.) Argent, *C. pterobryoides* Argent, and are here considered to represent species of *Calyptothecium*. However, the two species that reach southern Africa have ± julaceous stems and are treated in *Pterobryopsis*.

1 Costa absent or very short, single or double, restricted to lower third of leaf . . . . . 1. *P. hoehnelii*
1 Costa single, occasionally spurred, extending to above midleaf:
 2 Leaves elliptical or oblong-ovate, upper margins plane and entire . . . . . 2. *P. acutifolium*
 2 Leaves broadly ovate to oval, upper margins inflexed and serrulate . . . . . 3. *P. rehmannii*

1. **Pterobryopsis hoehnelii** *(C. Müll.) Magill*, comb. nov. Type: Kenya, Mt Kenya, Leikipia region, *Hoehnel s.n.*

Neckera hoehnelii C. Müll. in Flora 73: 489 (1890). *Calyptothecium hoehnelii* (C. Müll.) Argent in J. Bryol. 7: 571 (1973).

Calyptothecium africanum Broth. in Bot. Jahrb. Syst. 20: 198 (1894). Syntypes: South Africa, *Rehmann 332* (PRE); Usambara: Hochwaelder; Lugulua-Wald; Muandara-Wald; Bulua-Wald; Hochwald, *Holst 9044, 2636, 2621, 4312, 3291*.

Plants large, somewhat scattered or forming large turfs, yellow-green; corticolous or terricolous. *Primary stems* long-creeping; secondary stem erect, 30–100 mm long, branches distichous above stipe, pinnate; in section oval, central strand absent, inner cortical cells thin-walled, yellowish, in 5–7 rows, outer cortical cells thick-walled, smaller, red-brown, in 3–5 rows; axillary hairs very short, 2 or 3 cells long, apical cell larger, brownish; paraphyllia absent; pseudoparaphyllia filamentous, 8–12 cells long, 2 or 3 cells wide at base. *Leaves* crowded, concave, spreading wet, somewhat appressed to spreading dry; stem leaves oblong to oblong-ovate, 2.5–4.0 mm long; acuminate; subcordate at base; margins broadly incurved above, entire; branch leaves similar to stem leaves although generally small-

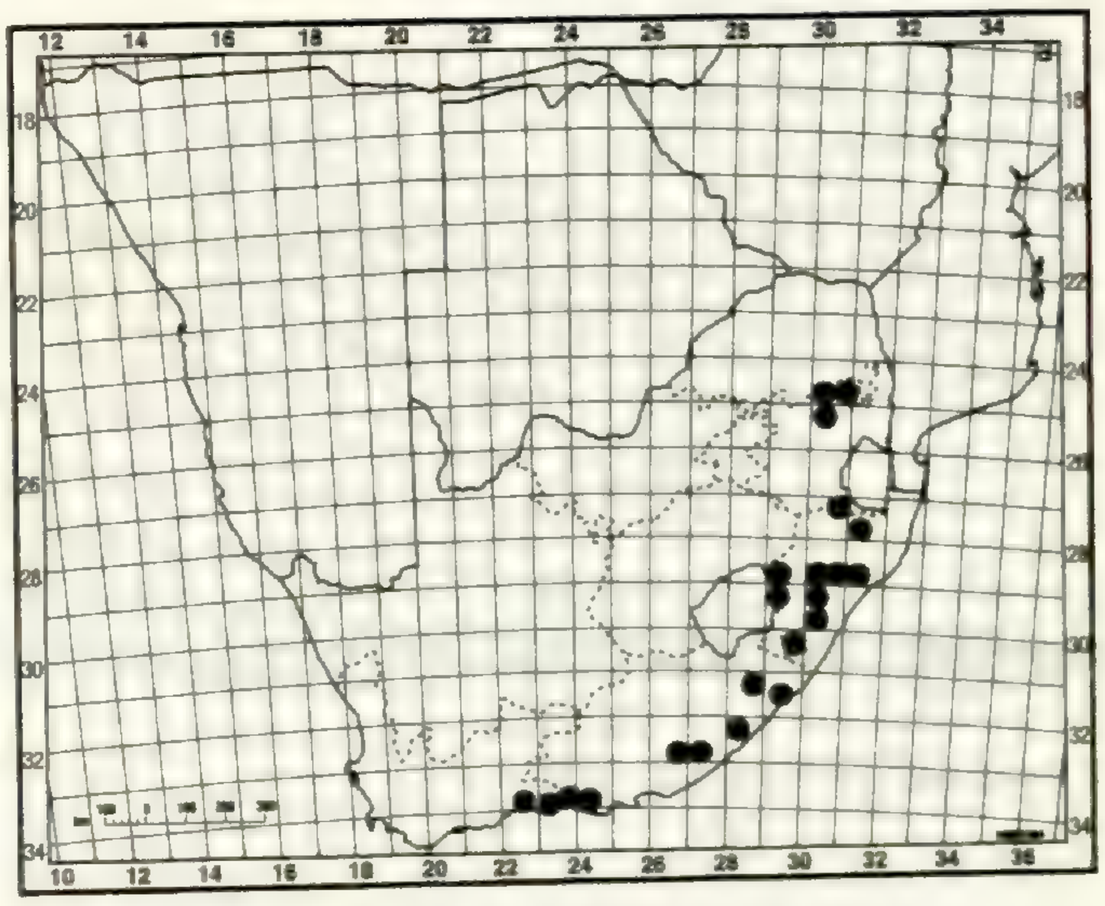
er. *Costa* absent, short and double or short and single, restricted to lower leaf, weak, smooth, hyaline; in section elliptical consisting of a group of 4 slightly smaller cells. *Upper laminal cells* linear-fusiform, homogeneous, 75–120 µm long, 7–8 µm wide, walls incrassate and pitted, smooth; basal cells ± rectangular, forming distinct group across insertion, 25–50 µm long, 6–12 µm wide, brownish, walls thickened and pitted, smooth; alar cells not differentiated. *Gemmae* in leaf axils, filiform, of 6–10 cells, 55–175 µm long, brownish green, smooth.

Dioicous. *Perigonia* gemmate, perigonial leaves ovate-cuspidate. *Perichaetia* green; perichaetial leaves ovate, long-acuminate, 4.5–5.5 mm long, leaf cells linear, thickened and pitted. *Seta* yellowish, smooth. *Capsule* immersed, erect, ovoid, 1.2–2.0 mm long, smooth, brownish; neck not differentiated; exothecial cells irregularly rectangular, walls thin, cells at mouth quadrate and darker; stomata not seen. *Peristome* single, yellow-red; prostome present; exostome teeth irregular, linear-lanceolate, smooth, to 400 µm high; endostome absent. *Operculum* conic-rostrate, 0.5 mm long. *Calyptra* small. *Spores* rounded, heterosporous, 25–48 µm, granulate, brown. Fig. 158: 1–13.

Found in forests of eastern, central and southern Africa and the island of Bioko, *P. hoehnelii* is the most commonly encountered species of *Pterobryopsis* in Africa. In southern Africa, the species is found on trees, soil and rock in forests of the eastern Transvaal region, Zululand, KwaZulu-Natal, and the eastern and southern Cape. Map 220.

Vouchers: *Crosby & Crosby 13381a; Magill 5122, 6036; Schelpe 7518; Van Rooy 880.*

The plants usually cover large areas on tree trunks and branches, rocks or soil at the base of



MAP 220.—**Pterobryopsis hoehnelii**

trees. The large, ± dendroid plants are usually recognized by their size, large concave leaves, entire leaf margins, short or absent costa, and smooth, strongly thickened and pitted leaf cells. Some specimens have been seen with leaves only weakly concave. However, most plants have strongly concave leaves.

Sporophytes are frequently found on *P. hoehnelii* although the immersed capsules, large green perichaetial leaves and densely leaved stems make them inconspicuous.

2. **Pterobryopsis acutifolium** *(Brid.) Magill*, comb. nov. Type: Mascarene Isl., Réunion, *s.l.*, no. XI.

Neckera acutifolia Brid., Bryol. univ. 2: 757 (1827). *Calyptothecium acutifolium* (Brid.) Broth. in Par., Index bryol., edn 2, 1: 288 (1904); Argent in J. Bryol. 7: 571 (1973).

Calyptothecium subacutifolium Broth. in Bot. Jahrb. Syst. 24: 254 (1897). Type: South Africa, Pondoland, Egorawald, *Beyrich 40.*

FIG. 158.—**Pterobryopsis hoehnelii** (1–13): **1.** habit (dry), × 1; **2.** distal part of branch with sporophyte (wet), × 5; **3.** stem in cross section (cells partly shown), × 175; **4.** leaf, × 25; **5.** leaf in cross section, × 175; **6.** basal leaf cells (left side), × 175; **7.** upper laminal cells, × 350; **8.** leaf apex, × 122; **9.** perichaetial leaf, × 25; **10.** part of capsule mouth with peristome teeth, × 122; **11.** operculum, × 35; **12.** calyptra, × 35; **13.** spore, × 490. **P. acutifolium** (14–18): **14.** habit (dry), × 1; **15.** leaf, × 35; **16.** basal leaf cells (left side), × 175; **17.** upper laminal cells at right margin, × 350; **18.** leaf apex, × 175. **P. rehmannii** (19–23): **19.** habit (dry), × 1; **20.** leaf, × 35; **21.** basal leaf cells (left side), × 175; **22.** upper laminal cells at right margin, × 350; **23.** leaf apex, × 175. (1, *Brenan 3352*; 2 & 10–13, *Sim 7125*; 3–5, 7 & 9, *Sim 7014*; 6 & 8, *Crosby 7792*; 14, *Sim PRE-CH9993*; 15 & 16, *Magill 5583*; 17 & 18, *Crosby 7843*; 19–23, *Buchanan s.n.*)

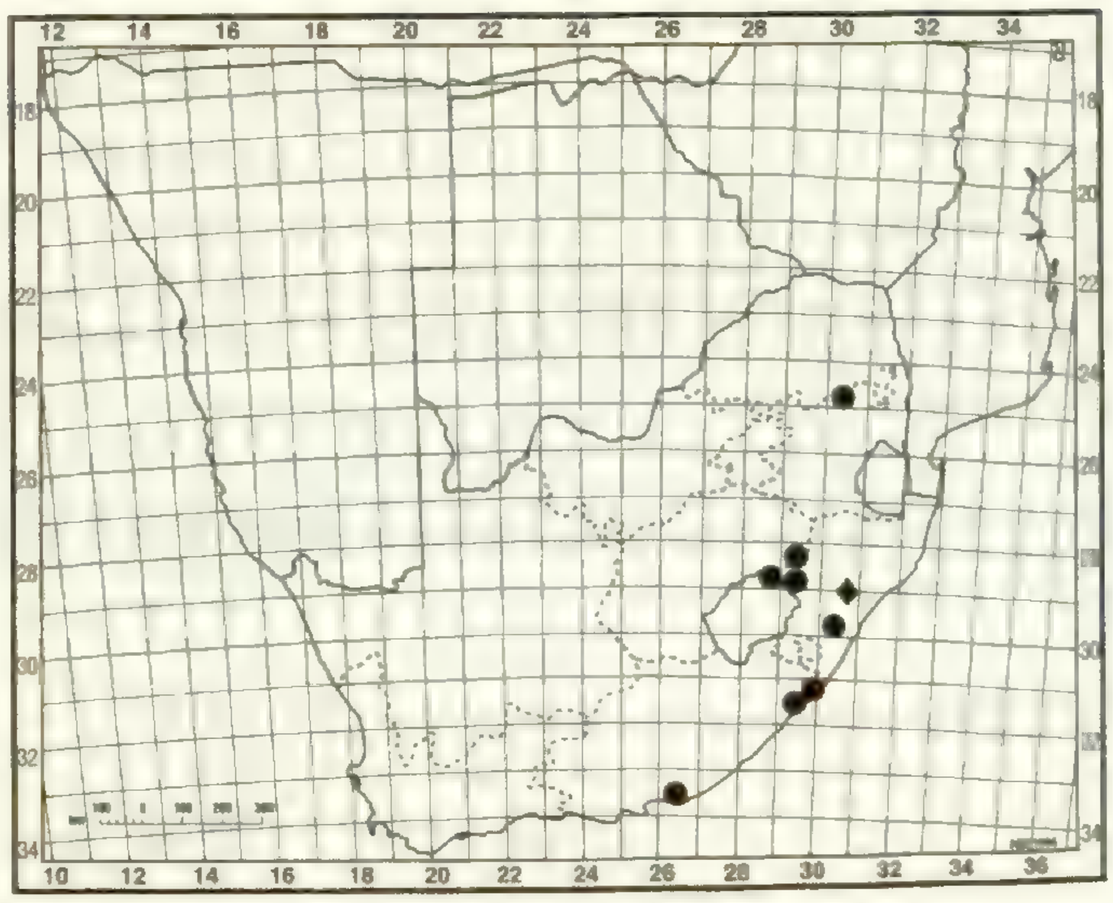
Plants medium-sized, forming large turfs, green to yellow-green; corticolous or saxicolous. *Primary stems* creeping; secondary stem erect, 20–70 mm long, branching irregular, distichous above stipe, pinnate; in section oval, central strand absent, inner cortical cells large, hyaline, thin-walled, in 3–5 rows, outer cortical cells smaller, brownish, thick-walled, in 4–6 rows; axillary hairs not seen; paraphyllia absent; pseudoparaphyllia filamentous. *Leaves* crowded, erect-spreading wet, appressed dry, somewhat crisped, concave; stem leaves ovate, elliptical or oblong-ovate, 2.6–3.2 mm long; acute; cordate to subauriculate at base; margins plane, entire; branch leaves similar but smaller. *Costa* single, slender, ending below apex, smooth; in section bulging dorsally, 2 cells thick. *Upper laminal cells* fusiform, homogeneous, 50–75 µm long, 6–8 µm wide, walls thickened and pitted, smooth; basal cells rectangular, much shorter and brownish at insertion, walls incrassate and pitted; alar cells not differentiated. *Gemmae* in leaf axils, few, filiform, of 4–8 cells, to 62 µm long, greenish, smooth.

Dioicous. *Perigonia* gemmate. *Perichaetia* green. *Sporophyte* not seen but described as: *Seta* very short. *Capsule* immersed, ovoid. *Peristome* single, yellowish, teeth irregular. *Operculum* conic-rostrate. *Calyptra* cucullate. *Spores* rounded, variable, 18–40 µm, papillose. Fig. 158: 14–18.

This species is known from forests throughout Africa and the African islands. In the *Flora* area *P. acutifolia* is infrequently collected on trees or rocks in forests of the eastern Transvaal area, KwaZulu-Natal and the eastern Cape region. Map 221.

Vouchers: *Crosby & Crosby 7843; Magill 3220, 5583; Sim 9993; Van Rooy 927, 1548.*

Pterobryopsis acutifolium is somewhat variable in plant size and leaf shape. The plants can be very short and compact or larger and full. The leaves, which exhibit some variation in shape of the lamina and apex, are occasionally crisped when dry. The plants are identified by their large size, single costa, entire leaf margins, and smooth, strongly thickened and pitted leaf cells.



MAP 221.— ● **Pterobryopsis acutifolium**
♦ **Pterobryopsis rehmannii**

3. **Pterobryopsis rehmannii** *Magill* in Magill & Schelpe in Mem. bot. Surv. S. Afr. 43: 5 (1979). Type: South Africa, Natal, *Buchanan s.n.* (Rehmann Musci Austro-africani 615; NH, holo.; BM).

Plants large, loose-tufted, green, glossy; corticolous. *Primary stems* long-creeping; secondary stem erect, up to 60 mm long, branches few, pinnate. *Leaves* crowded throughout, erect to imbricate wet or dry, concave; stem leaves broadly ovate, 2.0–2.2 mm long; acute; weakly decurrent at base; margins plane to inflexed above, serrulate above; branch leaves elliptical to oval, concave, 1.2–1.8 mm long; acute; margins plane to inflexed above, serrulate above. *Costa* single, ending below apex, slender, smooth. *Upper laminal cells* rhomboidal, homogeneous, 55–60 µm long, walls thickened, smooth; basal cells oblong, walls thickened, smooth; alar cells forming distinct groups, quadrate, walls thickened. *Gemmae* in leaf axils, scattered, cylindrical, of 6–8 cells, green, smooth.

Sporophyte not known. Fig. 158: 19–23.

Duplicate material of the specimen was distributed by Rehmann in the second part of his *Musci Austro-africani exsiccati*. The specimen

was collected in KwaZulu-Natal by Buchanan between 1861 and 1874, but no further collection data are available. From substrate fragments in the collection it appears that the specimen was collected from a tree. Map 221.

Voucher: type only.

The erect plants with short branches and imbricate, strongly concave, oval to broadly ovate leaves with serrulate upper margins identify this species. The plants are large and like other members of the genus probably cover large areas of trees and rocks in closed forests. It is therefore curious that *P. rehmannii* has not been recollected.

3. ORTHOSTICHOPSIS

Orthostichopsis *Broth.* in Natürl. PflFam. 1,3: 804 (1906); Argent in J. Bryol. 7: 597 (1973). Type species: *O. tetragonum* (Hedw.) Broth.

Plants large, frequently long and slender, erect when young, becoming pendent with age, yellow-green to brownish; corticolous or occasionally saxicolous. *Primary stems* long-creeping, naked or with scale leaves; secondary stems erect but stems and branches elongated and hanging with age; in section central strand absent. *Leaves* generally arranged in distinct spiral rows, but occasionally only branch leaves ranked; ovate to oval; acute to acuminate; margins broadly inflexed above, entire to serrulate, cordate at base. *Costa* single, extending to above midleaf, occasionally shorter, single or forked. *Leaf cells* oblong, thickened and pitted, smooth; alar cells forming a distinct group.

Dioicous. *Seta* very short. *Capsule* immersed. *Peristome* double, endostome rudimentary. *Operculum* short-rostrate. *Calyptra* hairy.

A genus of 20 species found in forests of Central and South America, Asia and Africa south of the Sahara. Two species are found in the *Flora* area, both rare and restricted to forests of the Transvaal regions, KwaZulu-Natal and the eastern Cape.

Leaves with a long, narrow acumen; plants frequently long-pendent, up to 150 mm long . . . . . 1. *O. subimbricata*

Leaves with a short apiculus; plants usually short and erect, 10–40 mm long . . . . 2. *O. pinnatella*

1. **Orthostichopsis subimbricata** *(Hampe) Broth.* in Natürl. PflFam. 1,3: 805 (1906). Type: Madagascar, *Borchgrevink 13*.

Neckera subimbricata Hampe in Linnaea 38: 216 (1874). *Pilotrichella subimbricata* (Hampe) Jaeg. in Ber. Thätigk. St. Gallischen Naturwiss. Ges. 1875–1876: 255 (1877).

Neckera chrysoneura Hampe ex C. Müll. in Linnaea 40: 263 (1876). *Orthostichopsis chrysoneura* (C. Müll.) Broth. in Natürl. PflFam. 1,3: 805 (1906). Type: Comoro Island, Johanna, *Hildebrandt s.n.*, 1875.

Plants medium-sized to long and slender, pendent, green to yellow-green; corticolous. *Primary stem* long-creeping; secondary stem long-pendent, up to 150 mm long; branching irregular, subdistichous, up to 25 mm long; in section round to oval, central strand absent, inner cortical cells thin-walled, yellowish, in 4–6 rows, outer cortical cells smaller, thick-walled, red-brown, in 3 or 4 rows; paraphyllia absent; pseudoparaphyllia filamentous. *Leaves* somewhat crowded, concave, erect to spreading wet, ± appressed dry; stem leaves elliptical to ovate, 1.9–2.5 mm long; acuminate, hair-pointed; rounded to cordate at base; margins broadly inflexed above, serrulate above; branch leaves similar to stem leaves but somewhat smaller, 1.5–2.2 mm long; subulate and hair-pointed; cordate at base; margins broadly inflexed above, serrulate above. *Costa* single or forked, ending below apex, smooth; ventral surface cells elongate; dorsal surface cells elongate; in

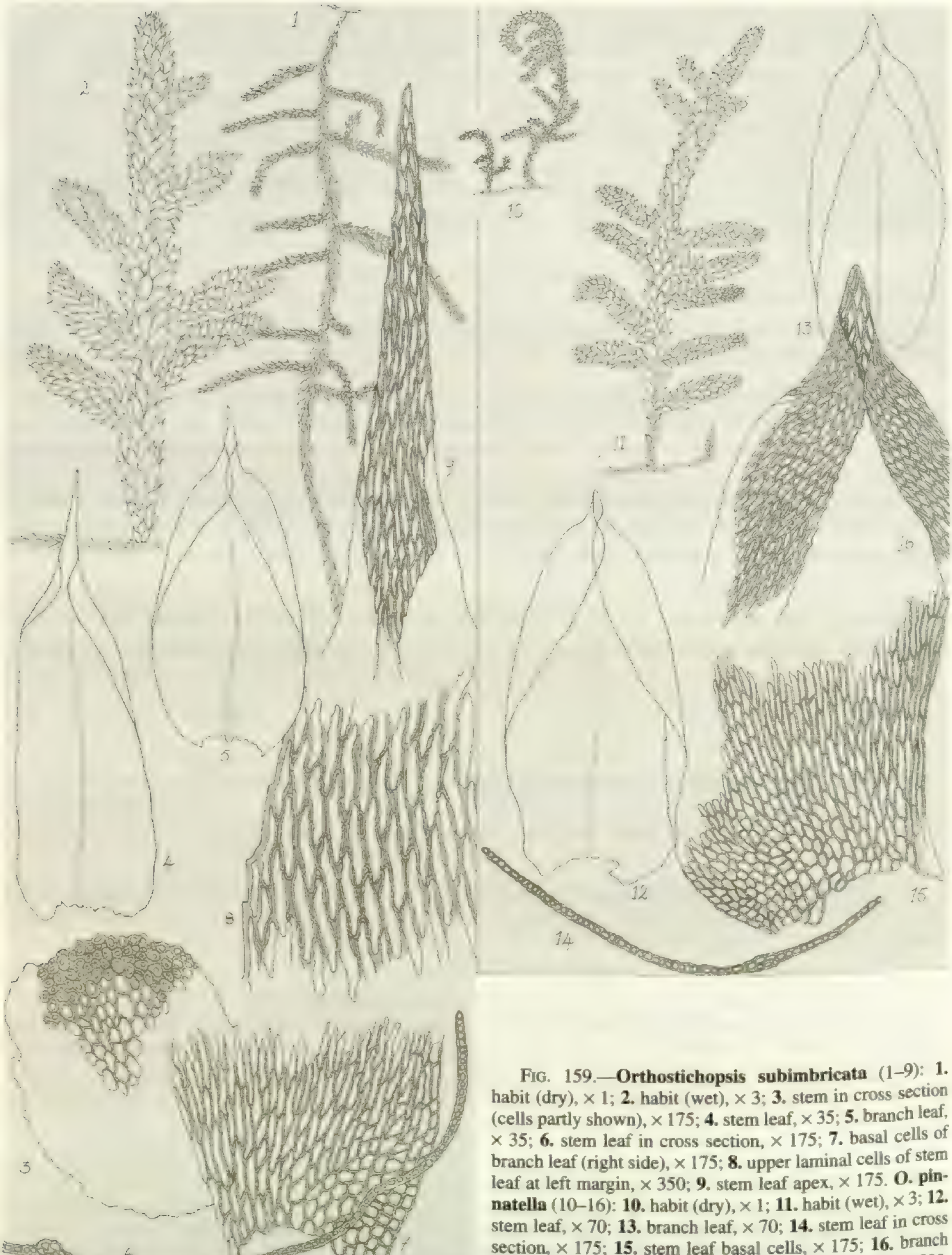


FIG. 159.—**Orthostichopsis subimbricata** (1–9): **1.** habit (dry), × 1; **2.** habit (wet), × 3; **3.** stem in cross section (cells partly shown), × 175; **4.** stem leaf, × 35; **5.** branch leaf, × 35; **6.** stem leaf in cross section, × 175; **7.** basal cells of branch leaf (right side), × 175; **8.** upper laminal cells of stem leaf at left margin, × 350; **9.** stem leaf apex, × 175. **O. pinnatella** (10–16): **10.** habit (dry), × 1; **11.** habit (wet), × 3; **12.** stem leaf, × 70; **13.** branch leaf, × 70; **14.** stem leaf in cross section, × 175; **15.** stem leaf basal cells, × 175; **16.** branch leaf apex, × 175. (1 & 3–9, *Crosby 13382*; 2, *Van Rooy 1890*; 10–16, *Magill 5440*.)

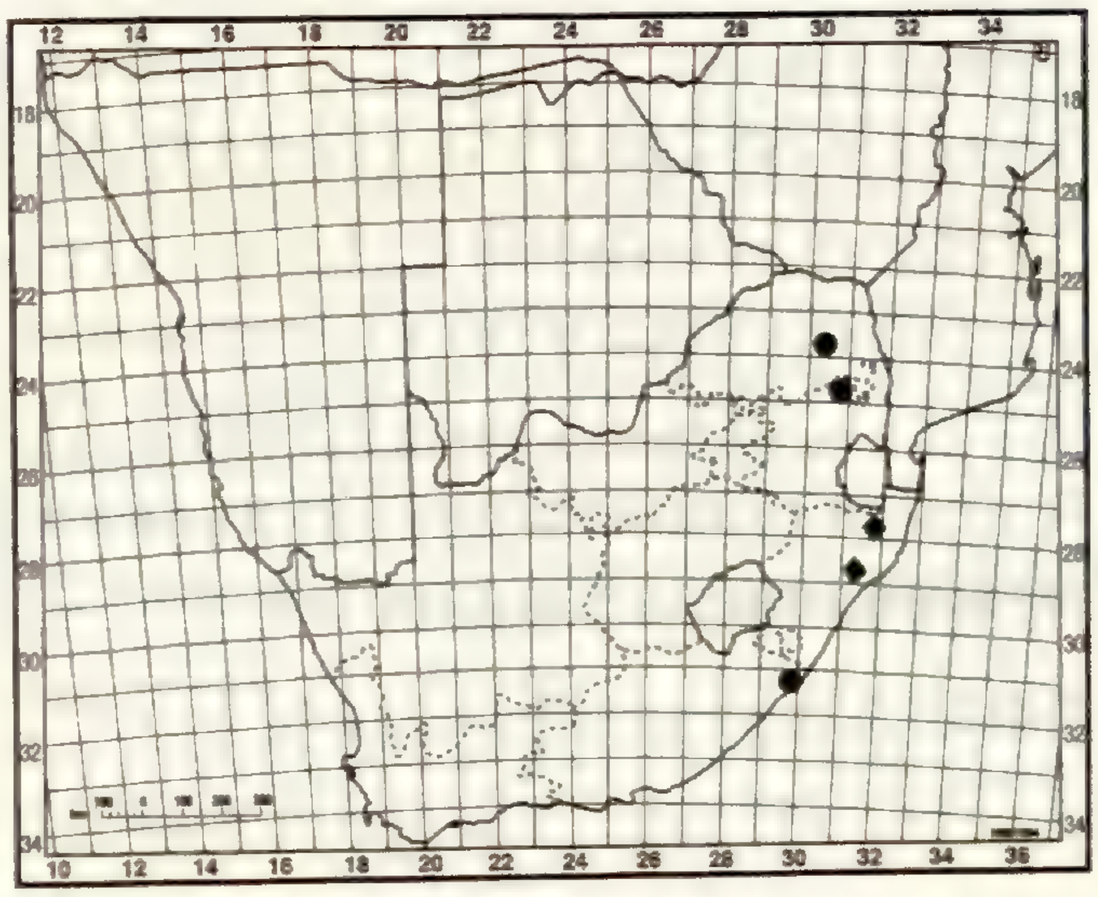
section flat, consisting of 6–8 undifferentiated cells. *Upper laminal cells* linear, weakly sigmoid, homogeneous, 37–62 µm long, 3–6 µm wide, walls incrassate and pitted, smooth; basal cells rectangular, 40–50 µm long, 6–8 µm wide, yellowish, walls incrassate and pitted, smooth; alar cells strongly differentiated, quadrate, yellow-brown, walls incrassate and pitted.

Dioicous? *Perigonia* not seen. *Perichaetia* not strongly differentiated, green; perichaetial leaves convolute, acuminate, 1.2 mm long. *Sporophyte* not known from southern Africa but capsule described as immersed. Fig. 159: 1–9.

The species is found in forests of eastern and southern Africa and the East African islands. In the *Flora* area, *O. subimbricata* is found in dense forests of the northern and eastern Transvaal regions and the eastern Cape area. Map 222.

Vouchers: *Crosby & Crosby 13375A, 13382; Van Rooy 1890.*

The plants could be easily confused with *Squamidium* of the Meteoriaceae. However, *Orthostichopsis* does not exhibit the blackening of leaves and stems common in *Squamidium*. In addition the costa in *Orthostichopsis*, although somewhat variable, is always stronger than that of *Squamidium* and the alar cells are not as pronounced. The weakly seriate branch leaves of this species resemble those of *Pilotrichella*, but the differences in costa type and length as well as capsule exsertion separate the taxa.



MAP 222.— ● **Orthostichopsis subimbricata**
♦ **Orthostichopsis pinnatella**

2. **Orthostichopsis pinnatella** *(Broth.) Broth.* in Natürl. PflFam. 1,3: 805 (1906). Type: Tanzania (Usambara), *Holst 9205e*.

Pilotrichella pinnatella Broth. in Bot. Jahrb. Syst. 20: 198 (1894).

Plants small, forming mats, green to yellow-green; corticolous or saxicolous. *Primary stems* long-creeping, flattened, with appressed scale leaves; secondary stems erect, 10–40 mm long, branching ± regular, distichous above stipe, curved when dry, pinnate; in section oval, central strand absent, inner cortical cells thin-walled, yellowish, 3 or 4 cells wide, outer cortical cells smaller, thick-walled, red-brown, 3 or 4 cells wide; paraphyllia absent; pseudoparaphyllia filamentous. *Leaves* somewhat crowded, in ranks, erect wet, ± appressed dry, strongly concave; stem leaves elliptical to ovate, 0.8–1.1 mm long; apiculate; rounded to subauriculate at base; margins broadly inflexed above to overlapping at apex, serrulate; branch leaves similar but smaller than stem leaves, 0.5–0.8 mm long. *Costa* single and extending to midleaf or above, occasionally forked, sometimes shorter and double in branch leaves; dorsal and ventral surface cells elongate, smooth; in section elliptical, a small group of 6–8 cells in lower leaf. *Upper laminal cells* ± rhomboidal and sigmoid, heterogeneous, 15–25 µm long, 5–8 µm wide, walls weakly thickened, smooth; basal cells rectangular, 20–28 µm long, 6–8 µm wide, yellowish, walls thickened, smooth; alar cells quadrate, forming distinct groups, yellow, walls thickened.

Gametangia and sporophytes not known. Fig. 159: 10–16.

Known only from the African mainland, *O. pinnatella* is found in forests of Tanzania, Malawi and South Africa. In southern Africa

the plants grow in small clumps on trees in forests of Zululand. Map 222.

Vouchers: *Crosby & Crosby 7799; Magill 5440.*

The rather small, dendroid plants are usually quite distinctive; although when growing in large mats, the strongly seriate, concave leaves resemble those of *Pilotrichella*. *Orthostichopsis pinnatella* can be separated from species of *Pilotrichella* by its long, single costa, serrulate upper leaf margins, shorter leaf cells, and distinct, although small group of alar cells. The costa of *O. pinnatella* is somewhat variable, and some leaves may have a very short and double costa restricted to the lower leaf, but most branch and stem leaves have a single, slender or occasionally forked costa, extending to the upper leaf.

METEORIACEAE

Plants slender and creeping with long-pendent branches, green to yellow-green, frequently becoming blackish on older parts of stem and branches; corticolous or saxicolous. *Primary stems* appressed to substrate, highly branched; in section generally with weak central strand; paraphyllia and pseudoparaphyllia absent. *Leaves* appressed or widespreading, frequently concave; ovate to elliptical; acute to long-acuminate or piliferous; margins plane or incurved above, entire or weakly serrate, rounded to base, frequently decurrent. *Laminal cells* short or long, thickened and frequently pitted, generally papillose; basal cells distinct; alar cells mostly differentiated.

Dioicous or autoicous. *Perichaetia* frequently distinctive. *Seta* elongate. *Capsule* exserted or immersed. *Peristome* double, well developed; exostome teeth 16, yellowish, somewhat striate below, papillose above; endostome segments almost as high as teeth, thin, hyaline, above a frequently high basal membrane, cilia present or absent. *Operculum* conic-rostrate. *Calyptra* cucullate or mitrate. *Spores* small, weakly papillose.

1 Costa short and double or lacking ..... 1. **Pilotrichella**
1 Costa single, extending to above midleaf, frequently very fine:
 2 Leaf cells smooth ..... 2. **Squamidium**
 2 Leaf cells papillose:
  3 Cells with a single papilla ..... 3. **Aerobryopsis**
  3 Cells with several papillae over lumen:
   4 Median leaf cells short-elliptic; leaf margins entire; branch leaves generally appressed ..... 4. **Papillaria**
   4 Median leaf cells elongate, ± fusiform; leaf margins serrate; branch leaves spreading ..... 5. **Floribundaria**

1. PILOTRICHELLA

Pilotrichella *(C. Müll.) Besch.* in Mém. Soc. Sci. Nat. Cherbourg 16: 222 (1872); Sim, Bryo. S. Afr. 395 (1926); Broth. in Natürl. PflFam., edn 2, 11: 157 (1925). Type species: *P. imbricata* (P. Beauv.) Besch.

Neckera subsect. *Pilotrichella* C. Müll., Syn. musc. frond. 2: 129 (1850).

Plants frequently in large pendent masses, dull green to yellow-green; saxicolous or corticolous. *Stems* creeping or pendent; branches usually long- pendent. *Leaves* panduriform, deeply concave, often in spiral rows; apiculate to piliform; margins entire or minutely serrate. *Costa* short and double or absent. *Laminal cells* elongate, smooth; alar cells generally forming distinct group.

Perichaetia not obvious. *Seta* straight, smooth. *Capsule* exserted, ovoid. *Peristome* double. *Operculum* conic-rostrate. *Calyptra* cucullate, pilose.

A genus of about 65 species found throughout Africa and Central and South America. The genus is recognized by its small, strongly concave, frequently panduriform leaves with a sharp apex and smooth leaf cells. The southern African species is uniform throughout its range.

Pilotrichella pandurifolia *(C. Müll.) Jaeg.* in Ber. Thätigk. St. Gallischen Naturwiss. Ges. 1875–1876: 255 (1877); Broth. in Natürl. PflFam., edn 2, 11: 158 (1925); Sim, Bryo. S. Afr. 395 (1926). Type: Cape, *Zeyher s.n.*, 1823 (BM).

Neckera pandurifolia ('*panduraefolia*') C. Müll. in Bot. Zeitung (Berlin) 13: 767 (1855).

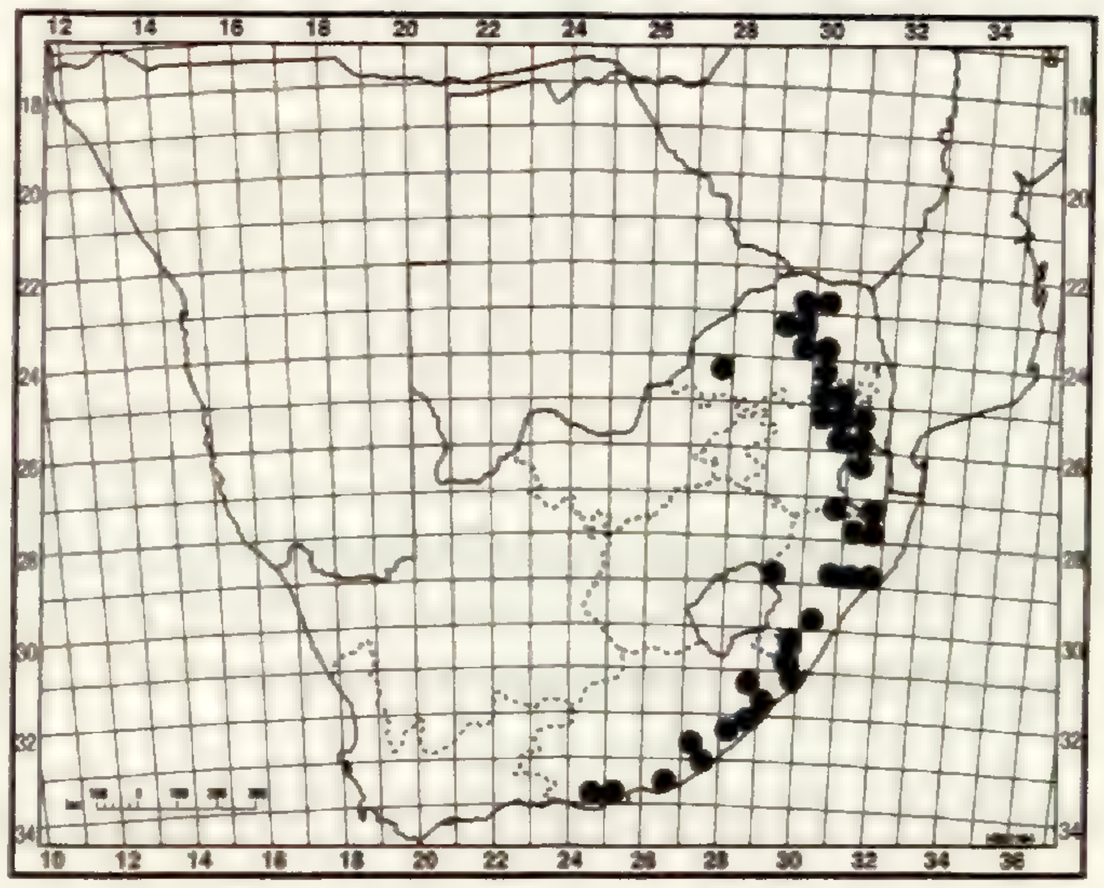
Pilotrichella kuntzei C. Müll. in Hedwigia 38: 127 (1889). Type: Cape, Kingwilliamstown, Perie Forest, *Kuntze s.n.*, 1894.

Pilotrichella cuspidata Broth. in Bot. Jahrb. Syst. 24: 255 (1897). Syntypes: Pondoland, *Beyrich 38, Bachmann 6*.

Pilotrichella conferta Ren. & Card. in Bull. Soc. Roy. Bot. Belg. 38,1: 24 (1900). Type: Lesotho, *Vernet s.n.* (PC).

Plants long and slender, forming dense pendent masses, light green to yellow-brown or dark green; saxicolous or corticolous. *Primary stems* creeping; secondary stems erect to pendent, 20–150 mm long, branches few, occasionally erect and dendroid in new secondary growth; in section round, central strand absent, inner cortical cells in 5 rows hyaline, thick-walled, outer cortical cells in 4 or 5 rows smaller, thick-walled, yellow-brown. *Leaves* crowded, erect-spreading wet, spreading dry; stem leaves obovate-cuspidate, 1.5–2.0 mm long; margins erect, entire; branch leaves generally panduriform; obovate to oblong, 0.8–1.5 mm long; acute; cuspidate or sometimes mucronate; ± auriculate or rounded at base; margins plane below, becoming erect to incurved above, entire. *Costa* short and double or absent, ventral and dorsal surfaces smooth; in section consisting of 3 or 4 undifferentiated cells. *Upper laminal cells* oblong-fusiform; 35–50 µm long, walls weakly thickened, smooth; basal cells similar to somewhat longer juxtacostally; alar cells few quadrate, walls weakly thickened.

Dioicous. *Perigonia* on branches, gemmate. *Perichaetia* along branches; perichaetial leaves long-sheathing, 2.0–2.6 mm long, leaf cells linear. *Seta* 2–3 mm long, yellow-brown; vaginula 2 mm long, beset with hairs that reach base of urn. *Capsule* exserted, erect, ovoid, 1–2 mm long, smooth, brown, neck weakly differentiated; exothecial cells subquadrate to subhexagonal, walls weakly thickened, cells at mouth brownish; stomata few, phaneropore. *Peristome* double, yellow; exostome teeth fragile, triangular, papillose, 0.4 mm high; endostome segments linear above very low basal membrane, perforated, almost as long as teeth, smooth; cilia rudimentary. *Operculum* conic-rostrate, to 1.5 mm long. *Calyptra* not seen. *Spores* rounded, 20–25 µm, papillose, green. Fig. 160: 1–11.



MAP 223.—**Pilotrichella pandurifolia**

Pilotrichella pandurifolia is known from forests of eastern and southern Africa. In the *Flora* area the species is found on boulders, rocks and trees in the forests of the northern, central and eastern Transvaal areas, Swaziland, Zululand, KwaZulu-Natal and the eastern and southern Cape regions. Map 223.

Vouchers: *Magill 3731, 5445, 6584; Smook & Phelan 672; Stirton 9929; Von Breitenbach 353*.

The 5-ranked, strongly concave, panduriform branch leaves and short double costa should place specimens of this species. The

FIG. 160.—**Pilotrichella pandurifolia** (1–11): **1.** habit (dry), × 1; **2.** part of secondary stem with branches (wet), × 3; **3.** part of stem in cross section, × 175; **4.** stem leaf, × 35; **5.** branch leaf, × 35; **6.** basal cells of branch leaf, × 175; **7.** upper laminal cells of branch leaf at left margin, × 490; **8.** cells at branch leaf apex, × 245; **9.** perichaetial leaf, × 35; **10.** part of capsule mouth with peristome, × 122; **11.** spore, × 700. **Squamidium brasiliense** (12–22): **12.** distal part of secondary stem with branches (dry), × 1; **13.** part of secondary stem with branches (wet), × 3; **14.** part of stem in cross section, × 175; **15.** stem leaf, × 32; **16.** branch leaf, × 32; **17.** basal cells of branch leaf, × 175; **18.** upper laminal cells of branch leaf, × 320; **19.** branch leaf apex, × 175; **20.** perichaetial leaf, × 18; **21.** part of capsule mouth with peristome, × 70; **22.** spore, × 700. (1–8, *Burrows 5039*; 9–11, *Sim PRE-CH16623*; 12, *Filter 23*; 13, 14, 20–22, *Crosby 7902*; 15, 16 & 18, *Crosby 13404*; 17 & 19, *Magill 5200*.)

above characters remain constant throughout the growth stages of the plants. Juvenile plants are frequently collected with stems short and unbranched. These plants quickly develop into an erect dendroid stage, somewhat like *Porothamnium*. In later stages the stems elongate up to 150 mm and have branches that frequently exceed 50 mm. This last stage results in the more typical habit, e.g. long-pendent stems hanging from boulders and tree trunks. Sporophytes are frequently found on the distal branches.

2. SQUAMIDIUM

Squamidium *(C. Müll.) Broth.* in Natürl. PflFam. 1,3: 807 (1906); Sim, Bryo. S. Afr. 390 (1926); Allen & Crosby in J. Hattori Bot. Lab. 61: 431 (1986). Type species: *S. lorentzii* (C. Müll.) Broth.

Plants large and pendent, green to yellow-green with blackish tint on older parts of stems and branches; terricolous or saxicolous. *Primary stems* long-creeping; secondary stems and branches long and pendent. *Leaves* appressed, concave, abruptly cuspidate or piliferous; cordate and decurrent at base; margins plane, entire. *Costa* generally single, extending to upper leaf. *Laminal cells* linear-fusiform, smooth; alar cells strongly differentiated.

Perichaetia differentiated. *Seta* to 1 mm long, smooth. *Capsule* immersed, ovoid. *Peristome* double. *Operculum* convex. *Calyptra* cucullate, pilose.

A genus of seven species found in Central and South America, Africa, and the East African islands. The genus might be confused with *Orthostichopsis* of the Pterobryaceae but *Squamidium* has leaves with a stronger costa, decurrent leaf bases and no pseudoparaphyllia.

Squamidium brasiliense *(Hornsch.) Broth.* in Natürl. PflFam. 1,3: 809 (1906); Allen & Crosby in J. Hattori Bot. Lab. 61: 454 (1986). Type: Brazil, near Mandioccam, *Martius s.n.* (BM).

Antitrichia brasiliensis Hornsch., Fl. bras. 1,2: 52 (1840).

Meteorium biforme (Hampe) Besch. in Ann. Sci. Nat. Bot. 6. 10: 269 (1880); *Pilotrichella biformis* (Hampe) C. Müll. ex Geh., Abh. Naturwiss. Vereine Bremen 7: 209 (1881); *Squamidium biforme* (Hampe) Broth. in Natürl. PflFam. 1,3: 809 (1906). Type: Madagascar, Alamazantroskoven, *Borgen s.n.* (BM).

Pilotrichella rehmannii C. Müll. in Geh., Rev. Bryol. Lichénol. 5: 70 (1878); *Meteorium rehmannii* C. Müll., Hedwigia 38: 127 (1899); *Squamidium rehmannii* (C. Müll.) Broth., Natürl. PflFam. 1,3: 809 (1906); Sim, Bryo. S. Afr. 391 (1926). Lectotype: Cape, Montagu Pass, near Blanco, *Rehmann 323* (BM), vide Allen & Crosby, 1986.

Plants medium-sized to large, pendent, green to yellow-green turning blackish brown to black on older stems and branches; corticolous or saxicolous. *Primary stems* creeping; secondary stems pendent, julaceous, to 200 mm long, branching regular, in widely spaced groups of 2–5 branches; in section round, central strand variable, small or absent, inner cortical cells hyaline, thin-walled, in 6 rows, outer cortical cells yellow, thick-walled in 4 or 5 rows. *Leaves* ± crowded and concave, ± erect wet, appressed dry; stem leaves ovate-lanceolate to oblong, 3.5 mm long; abruptly setaceous; subcordate and decurrent at base; margins plane, entire, cells not differentiated; branch leaves broadly ovate to elliptical or oblong; abruptly cuspidate to setaceous; subcordate and decurrent at base; margins plane, entire. *Costa* variable, mostly single, extending to upper leaf, on stem leaves extending to midleaf, percurrent or short and double on branch leaves; ventral and dorsal surface smooth; in section flat, guide cells not differentiated, ventral and dorsal surface cells thick-walled. *Upper laminal cells* linear-fusiform, walls weakly thickened, homogeneous, smooth; basal cells rectangular, hyaline, walls thickened and pitted, smooth; alar cells strongly differentiated, quadrate, yellowish, walls thickened.

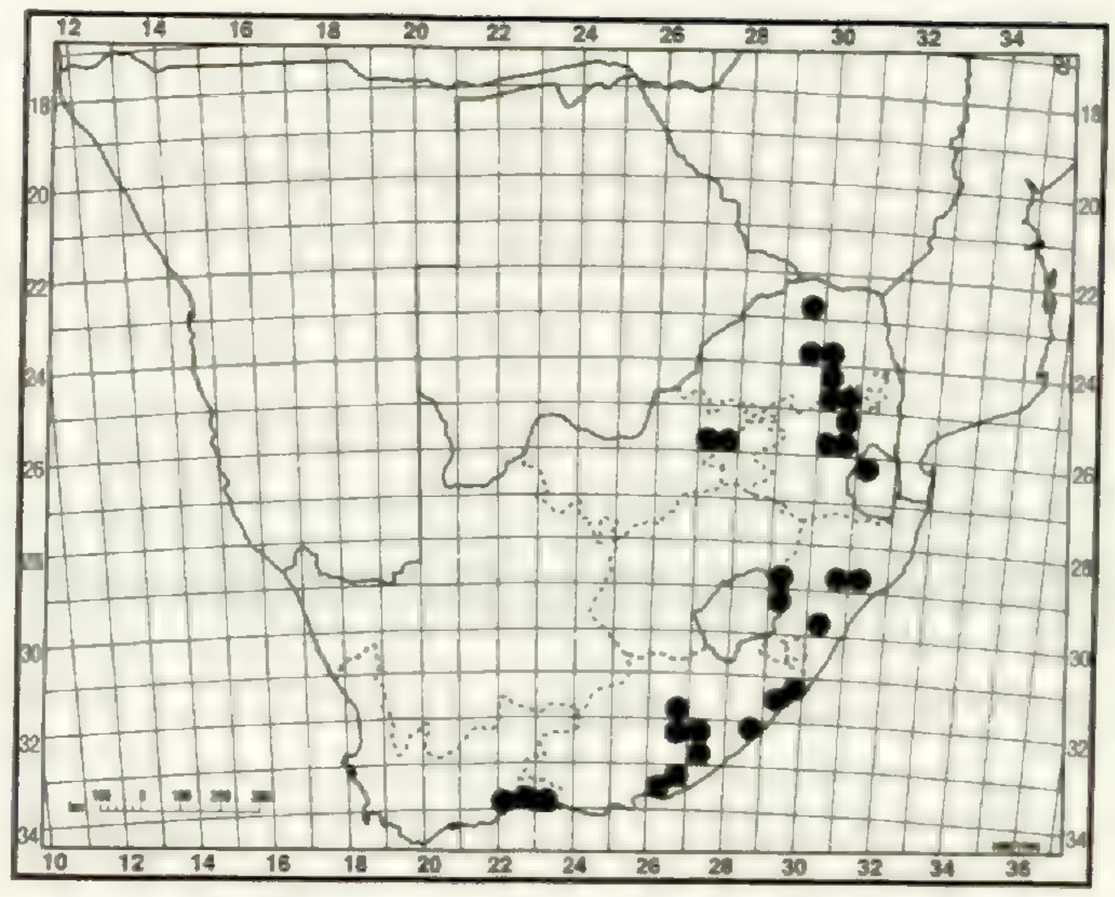
Dioicous. *Perigonia* on stems and branches, gemmate. *Perichaetia* along stem; perichaetial

leaves oblong-acuminate, base sheathing, 4 mm long, leaf cells linear, fusiform. *Seta* 0.5–1.0 mm long, brown, smooth. *Capsule* immersed, ovoid, 2 mm long, smooth, black-green, neck not differentiated; exothecial cells subquadrate broadly rectangular, walls thickened, cells at mouth quadrate, neck cells smaller; stomata phaneropore. *Peristome* double, yellow-brown; exostome teeth long-linear, smooth, papillose, 0.7 mm high; endostome segments linear above low basal membrane, perforated, shorter than teeth, smooth; cilia absent. *Operculum* ± convex, 0.7 mm long. *Calyptra* cucullate, 1 mm long, pilose. *Spores* rounded, 25–35 µm, granulate, yellow. Fig. 160: 12–22.

This species is known from South America, eastern and southern Africa and the East African islands. In the *Flora* area it is found on trees and boulders in forests of the northern, central and eastern Transvaal areas, Swaziland, Zululand, KwaZulu-Natal and the eastern and southern Cape regions. Map 224.

Vouchers: *Crosby & Crosby 7902; Filter 18; Leighton 3371a; Magill 5204, 6569; Pienaar 11.*

Squamidium brasiliense is recognized by its long, narrow, pendent stems with ± grouped, julaceous branches. The branch leaves are



MAP 224.—**Squamidium brasiliense**

erect-appressed and frequently strongly concave, making the branches appear fuller and much larger than the stem. The plants are green to yellow-green above but take on a shiny blackish or brownish black tint on older parts of stem or branches. This is also observed in other members of the family, e.g. *Papillaria*, although the plants are dull in appearance. *Squamidium brasiliense* might be confused with *Orthostichopsis* of the Pterobryaceae which is recognized by its leaves in 5-ranked spirals and filamentous pseudoparaphyllia.

3. **AEROBRYOPSIS**

Aerobryopsis *Fleisch.* in Hedwigia 44: 304 (1905); Broth. in Natürl. PflFam., edn 2, 11: 165 (1925); Sim, Bryo. S. Afr. 394 (1926); Noguchi in J. Hattori Bot. Lab. 41: 294 (1976); Gangulee, Moss. E. India 5: 1315 (1976). Type species: not designated.

Plants large, yellow-green, shiny, with blackish tint on older parts; mostly corticolous. *Primary stems* creeping; secondary stems and branches pendent. *Leaves* long-acuminate; cordate at base; margins plane, entire to serrulate. *Costa* single. *Laminal cells* linear-fusiform with single papilla over each lumen; alar cells not well defined.

Seta elongate, rough above. *Capsule* exserted. *Peristome* double. *Operculum* conic-rostrate. *Calyptra* cucullate, smooth or with a few hairs.

A genus of ± 25 species found mostly in Asia, three species are known from Central and South America, and one from Africa. *Aerobryopsis* is a lowland forest genus most easily recognized by its widely spreading, glossy leaves.

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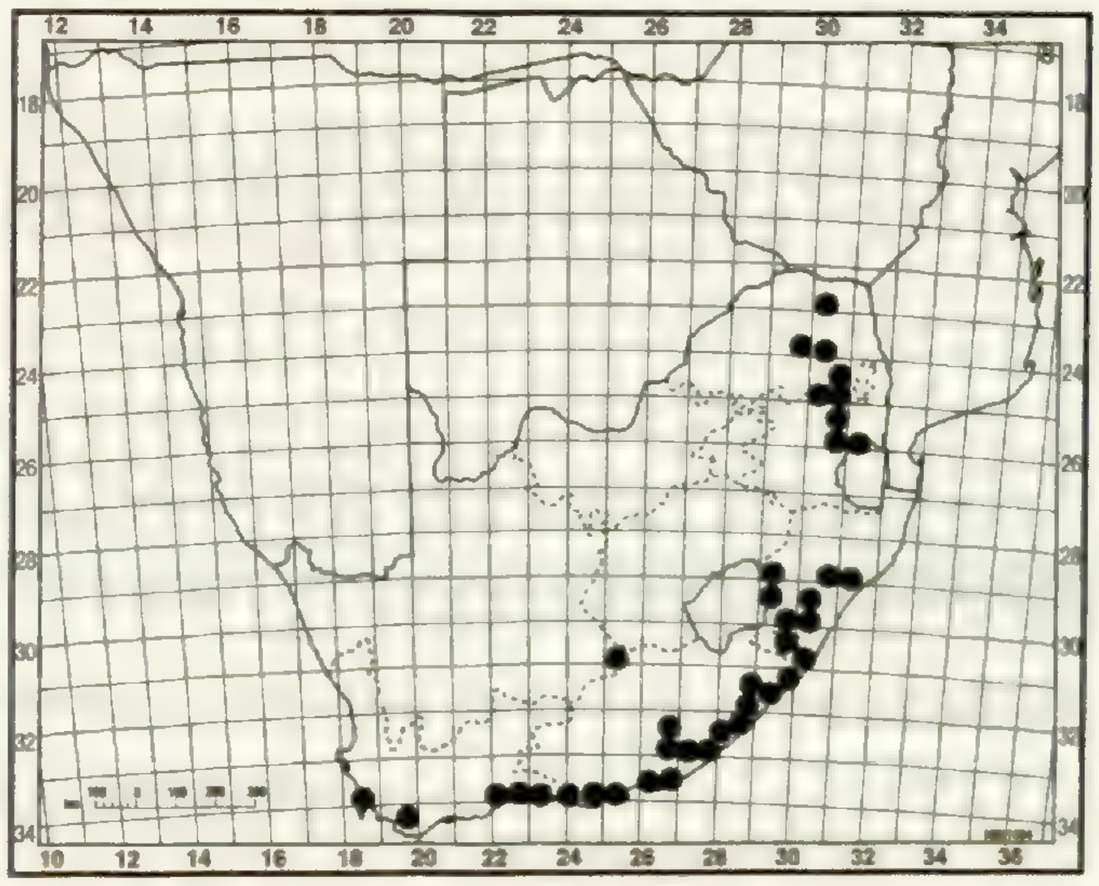
Aerobryopsis capensis *(C. Müll.) Fleisch.* in Hedwigia 44: 306 (1905); Broth. in Natürl. PflFam., edn 2, 11: 164 (1925); Sim, Bryo. S. Afr. 394 (1926). Type: Cape, Genadendal, *Breutel s.n.* (BM).

Neckera capensis C. Müll. in Bot. Zeitung (Berlin) 16: 165 (1858); *Aerobryum capense* (C. Müll.) C. Müll. in Linnaea 40: 262 (1876).

Aerobryum capense var. *rupestre* C. Müll. in Par., Index bryol. 9 (1894), nom. nud.; Sim, Bryo. S. Afr. 394 (1926).



MAP 225.—**Aerobryopsis capensis**

Plants medium-sized, pendent, yellow-green, glossy; corticolous or rarely terricolous. *Primary stems* flattened against substrate; secondary stems pendent, 200 mm long, branches irregular; in section round, central strand small, inner cortical cells in 5 or 6 rows, thin-walled towards margin, outer cortical cells in 6 rows, smaller, thick-walled. *Leaves* somewhat distant, widespreading to reflexed, wavy to weakly plicate; stem leaves ovate, 2.0–3.0 mm long; acuminate, acumens generally long and slender; cordate at base; margins plane, serrulate. *Costa* single, ending in acumen, ventral and dorsal surfaces smooth; in section elliptical, cells in 3 equal rows, weakly thickened. *Upper laminal cells* linear-fusiform, 50–76 µm long, walls thickened, pitted, papillose, papillae single, centred over cell lumens; basal cells rectangular, hyaline, walls more strongly thickened and pitted, yellowish, smooth; alar cells not differentiated.

Autoicous. *Perigonia* on branches, gemmate. *Perichaetia* along branches; perichaetial leaves acuminate with base sheathing, leaf cells linear-fusiform, thickened, pitted and smooth. *Seta* 15–20 mm long, yellow-brown. *Capsule* short-exserted, erect, short-cylindrical, 1.5–2.0 mm long, brown; exothecial cells subquadrate to rectangular, walls frequently collenchymatous; stomata few, phaneropore. *Peristome* double, yellow; exostome teeth broadly lanceolate, striate with median zigzag line, 700–800 µm high; endostome segments broadly keeled above high basal membrane, as long as teeth, ± smooth; cilia single, linear, short, papillose. *Operculum* rostrate. *Calyptra* cucullate, 1 mm long, smooth. *Spores* rounded, 12–17, granulate, brown. Fig. 161: 1–7.

The species is known from eastern and southern Africa. In the *Flora* area *A. capensis* is found in forests of the northern and eastern Transvaal areas, Zululand, KwaZulu-Natal, and the eastern, southern, central and southwestern Cape regions. Map 225.

Vouchers: *Magill 5557, 6022; Oliver 7179; Rankin 143; Russell 2692b; Van Rooy 769a.*

The glossy, yellow-green plants with widely spreading leaves when wet or dry help to identify *A. capensis*. The single, small papilla centred over the broadest part of the linear-fusiform leaf cells is distinctive in the family, but is also seen in *Trachypodopsis serrulata*.

FIG. 161.—**Aerobryopsis capensis** (1–7): **1.** habit (dry), × 1; **2.** distal part of secondary stem (wet), × 3; **3.** part of stem in cross section, × 175; **4.** leaf, × 35; **5.** basal leaf cells, × 175; **6.** upper laminal cells at left margin, × 350; **7.** cells at leaf apex, × 175. **Papillaria africana** (8–20): **8.** habit (dry), × 1; **9.** distal part of secondary stem with branch and sporophyte (wet), × 3; **10.** part of stem in cross section, × 175; **11.** leaf, × 35; **12.** part of leaf in cross section, × 175; **13.** basal leaf cells, × 175; **14.** upper laminal cells at left margin, × 350; **15.** cells at leaf apex, × 175; **16.** perichaetial leaf, × 25; **17.** part of capsule mouth with peristome, × 175; **18.** operculum, × 35; **19.** calyptra, × 18; **20.** spore, × 700. (1, *Van Rooy 769a*; 2, *Filter PRE-CH13387*; 3 & 4, *Crosby 7908*; 5, *Von Breitenbach 8*; 6, *Britten 2726b*; 7, *Von Breitenbach 317*; 8, 11, 12 & 14, *Van Rooy 1951*; 9, 16, 17 & 20, *Arnold 1331*; 10, *Crosby 9240*; 13 & 15, *Magill 3529*; 18, *Sim 7231*; 19, *Crosby 9198*.)

4. PAPILLARIA

Papillaria *(C. Müll.) C. Müll.* in Ofvers. Forh. Kongl. Svenska Vetensk.-Akad. 33: 34 (1876) nom. cons.; Broth. in Natürl. PflFam., edn 2, 11: 161 (1925); Sim, Bryo. S. Afr. 391 (1926); Noguchi in J. Hattori Bot. Lab. 41: 237 (1976); Gangulee, Moss. E. India 5: 1283 (1976). Type species: *P. nigrescens* (Hedw.) Jaeg.

Neckera subsect. *Papillaria* C. Müll., Syn. musc. frond. 2: 134 (1850).

Plants hanging, slender, dull, green to yellow-brown, frequently with blackish tint on older parts; corticolous. *Primary stems* creeping; secondary stems and branches pendent. *Leaves* lanceolate; cordate to auriculate at base; margins plane, entire to serrulate. *Costa* single, extending to midleaf or above. *Laminal cells* short or long, multipapillose; alar cells not strongly differentiated.

Dioicous. *Seta* elongate, smooth. *Capsule* exserted. *Peristome* double. *Operculum* conic-rostrate. *Calyptra* cucullate, pilose.

A genus of ± 78 species found in Central and South America, Africa and Madagascar, India, Asia, Australia and New Zealand, and some Pacific islands. The six species known from Africa are recognized by their slender, pendent habit, dull yellowish to yellow-brown colour with blackish tint on older stems and leaves, frequently auriculate leaves, and multipapillose leaf cells.

Papillaria africana *(C. Müll.) Jaeg.* in Ber. Thätigk. St. Gallischen Naturwiss. Ges. 1875–1876: 272 (1877); Broth. in Natürl. PflFam., edn 2, 11: 163 (1925); Sim, Bryo. S. Afr. 392 (1926). Type: Cape, Olifantshoek, *Ecklon s.n.* (BM).

Neckera africana C. Müll., Syn. musc. frond. 2: 137 (1850). *Meteorium africanum* (C. Müll.) Mitt., J. Linn. Soc., Bot. 22: 314 (1886).

Plants slender, creeping along substrate with pendent branches, green to yellow-green, dull; saxicolous or corticolous. *Primary stems* creeping; secondary stems pendent, to 400 mm long, branching irregular; in section round, central strand very small, inner cortical cells in 7 or 8 rows, weakly thickened, outer cortical cells in 4 or 5 rows smaller, thick-walled, yellow-green. *Leaves* erect-spreading wet, appressed dry; ovate to oval or oblong, (1.4–)1.7–2.0(–2.5) mm; abruptly long-acuminate, frequently extending out as a long smooth awn; cordate or ± subauriculate and decurrent at base; margins plane, entire. *Costa* ending in acumen, ventral and dorsal surfaces smooth; in section bulging dorsally, to 3 cells thick, guide cells not differentiated, dorsal surface cells thick-walled or not differentiated. *Upper laminal cells* elliptical to rounded rhombic, elongate-fusiform at apex, 10–12 µm long, walls weakly thickened, papillose; papillae small, scattered over lumen; apical and occasionally marginal cells smooth; basal cells quadrate to short rectangular, hyaline, smooth becoming elongate-fusiform, strongly thickened and pitted juxtacostally; alar cells small, quadrate.

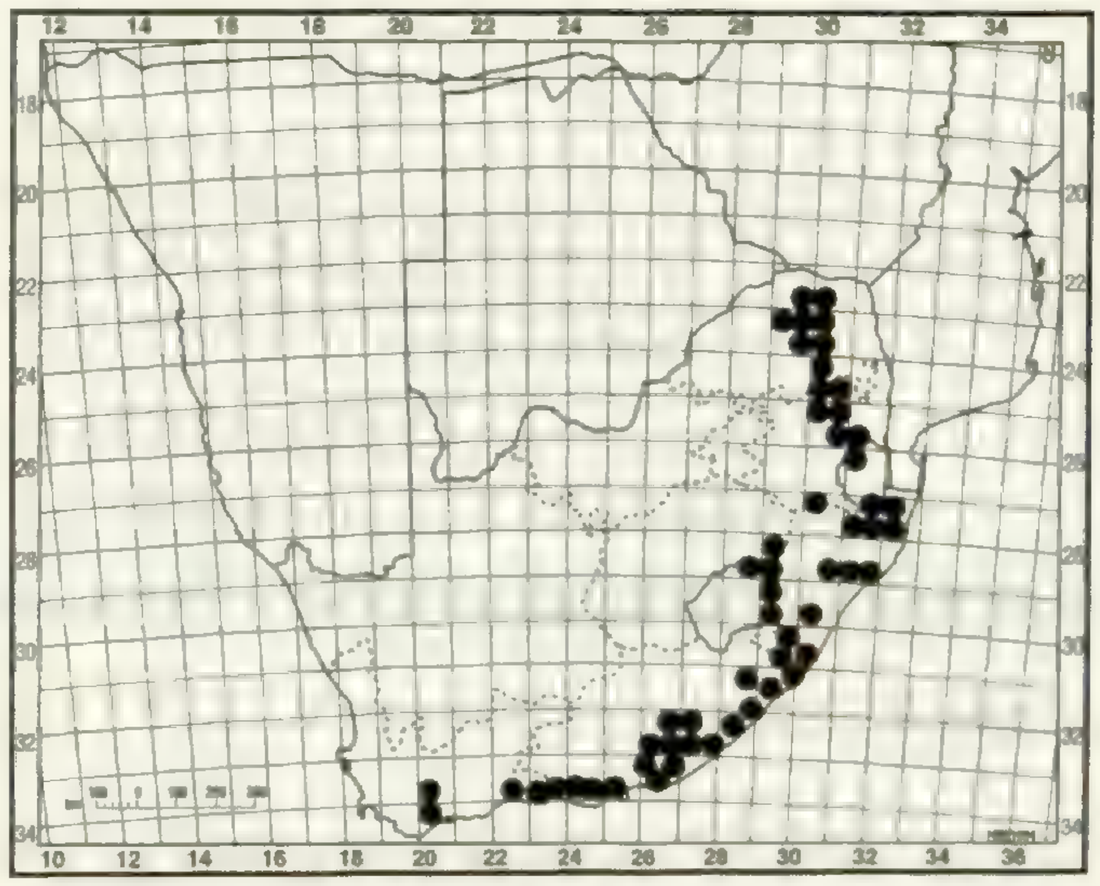
Dioicous. *Perigonia* on branches, gemmate. *Perichaetia* on distal branches; perichaetial leaves oblong, 2.2 mm long, leaf cells fusiform, thickened. *Seta* 2.5 mm long, brown; vaginula long with numerous long paraphyses reaching base of capsule. *Capsule* exserted, erect, ovoid, 1.5–2.0 mm long, smooth, green-brown to brown; exothecial cells quadrate to short rectangular, walls thin, cells at mouth slightly larger, darker; stomata numerous, phaneropore. *Peristome* yellow; exostome teeth lanceolate, papillose, perforated, 0.5 mm high; endostome segments linear above basal membrane, perforated, shorter than teeth, almost smooth; cilia absent. *Operculum* conic-rostrate, 1.0 mm long. *Calyptra* cucullate, 2 mm long, hairy. *Spores* rounded, 20–25 µm, papillose, green. Fig. 161: 8–20.

Found throughout eastern and southern Africa and the East African islands, *P. africana* grows hanging from branches of trees and bushes or less frequently on boulders in forests and closed wooded areas. In southern Africa the species is known from the northern and eastern

Transvaal areas, Swaziland, Zululand, KwaZulu-Natal and the eastern, southern and southwestern Cape regions. Map 226.

Vouchers: *Brenan 2795, 2841; Crosby 9198; Magill 3673, 5201; Oliver 7060; Rankin 44; Van Rooy 234.*

These plants are generally recognized by their slender, hanging branches and dull appearance. They might be confused with other plants with similar habit, e.g. *Trachypus, Squamidium* or *Floribundaria*, but leaf shape, laminal cells with scattered papillae, and differentiated basal juxtacostal cells should identify specimens of *P. africana*.



MAP 226.—**Papillaria africana**

5. FLORIBUNDARIA

Floribundaria *Fleisch.* in Hedwigia 44: 301 (1905); Broth. in Natürl. PflFam., edn 2, 11: 169 (1925); Sim, Bryo. S. Afr. 393 (1926); Noguchi in J. Hattori Bot. Lab. 41: 270 (1976); Gangulee, Moss. E. India 5: 1299 (1976). Type species: not designated.

Plants small, dull, pendent; corticolous. *Stems* regularly branched. *Leaves* small, ovate-acuminate, rounded at insertion; margins plane, entire to serrulate. *Costa* single, extending to midleaf. *Laminal cells* linear, ± seriate-papillose; alar cells not distinct.

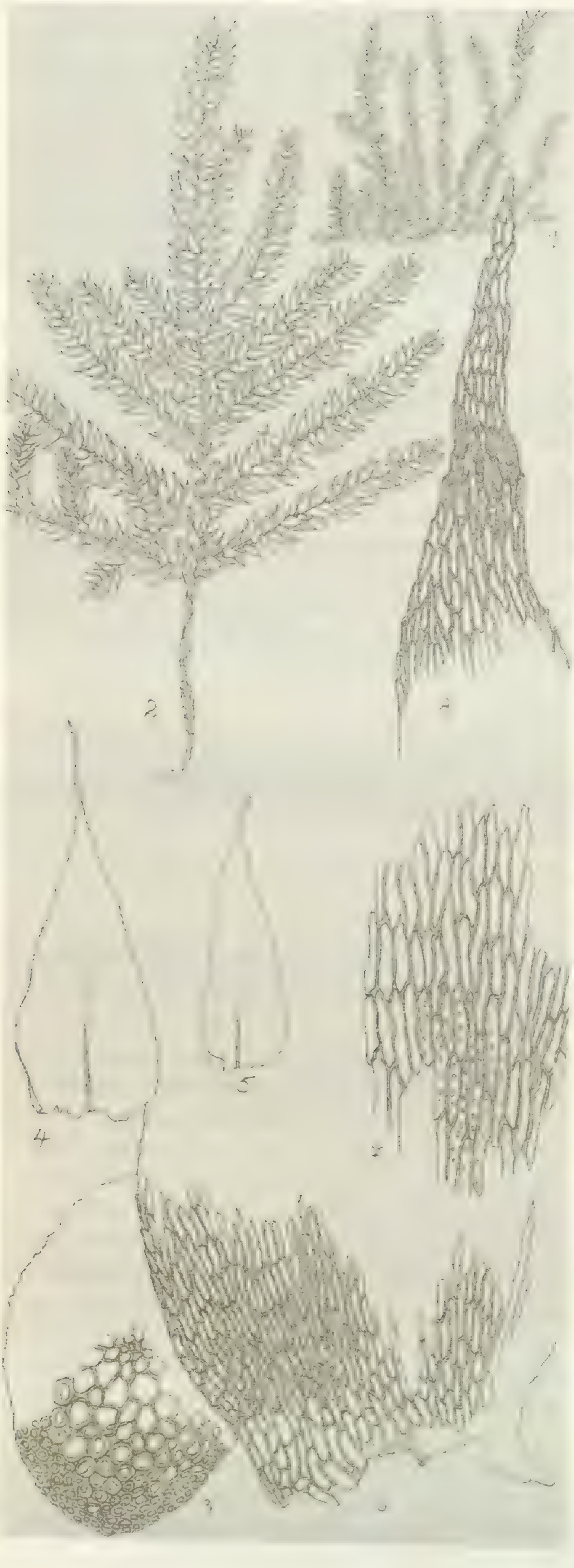
Seta elongate, smooth. *Capsule* exserted. *Peristome* double. *Operculum* conic-rostrate. *Calyptra* cucullate, sparsely hairy. *Spores* rounded, papillose.

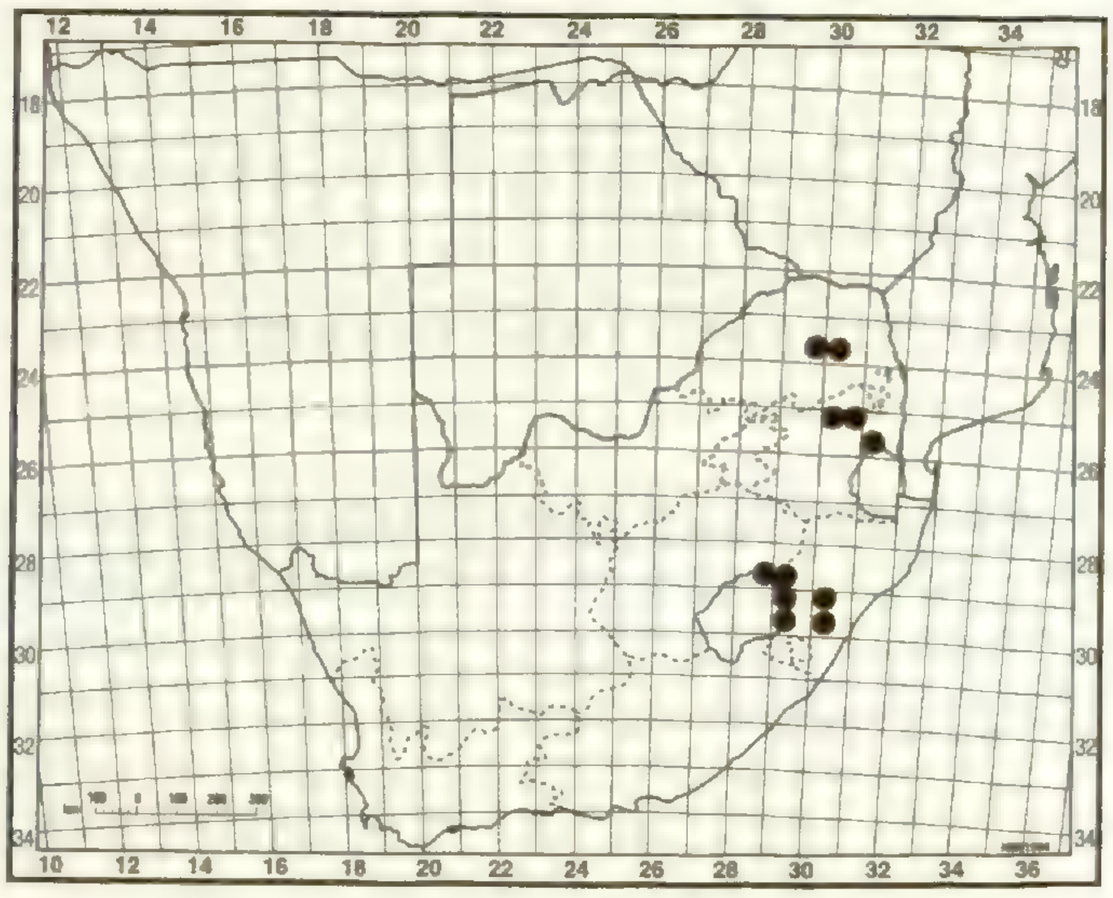
Floribundaria contains ± 34 species found in moist forests throughout the tropics. Two species are known from Africa, both recognized by their small, delicate habit and seriate leaf cell papillae.

Floribundaria floribunda *(Doz. & Molk.) Fleisch.* in Hedwigia 44: 302 (1905); Broth. in Natürl. PflFam., edn 2, 11: 170 (1925); Sim, Bryo. S. Afr. 393 (1926). Type: 'Java. Sumatra' (L, holo.) fide Streimann in J. Hattori Bot. Lab. 69: 277–312 (1991).

Leskea floribunda Doz. & Molk. in Ann. Sci. Nat. Bot. 3, 2: 310 (1844); *Meteorium floribundum* (Doz. & Molk.) Doz. & Molk., Musc. frond. ined. archip. ind. 6: 162. 53 (1848); *Neckera floribunda* (Doz. & Molk.) C. Müll. in Linnaea 36: 9 (1869); *Papillaria floribunda* (Doz. & Molk.) C. Müll. in Linnaea 40: 267 (1876).

Plants small, creeping over substrate or forming thick masses, yellow-green to light green; saxicolous or corticolous. *Stems* creeping, 10–40 mm long, branching irregular; in section round, central strand small, inner cortical cells in 4 rows, thin-walled, outer cortical cells in 3 or 4 rows, smaller, thick-walled, yellow-brown. *Leaves* distant, widespreading wet, reflexed and squarrose dry; stem leaves broadly ovate to ovate-lanceolate, 0.9–1.5 mm long; acuminate; rounded at base; margins plane, serrulate; branch leaves lanceolate to linear-lanceolate, 0.7–1.2 mm long; acuminate; rounded at base; margins plane, serrulate. *Costa* single, weak, extending to midleaf or beyond but always ending below apex, occasionally absent; in section consisting of an undifferentiated group of 4–6 cells. *Upper laminal cells* oblong-fusiform, 25–38 µm long, walls weakly thickened, papillose; papillae small, subseriate; basal





MAP 227.—**Floribundaria floribunda**

cells not differentiated, somewhat broader; alar cells and cells along insertion smooth.

Sporophyte not seen. Fig. 162.

Pantropical in distribution, *Floribundaria floribunda* is known from Africa and the East African islands, India, southern and southeastern Asia, Japan, Oceania, Australia, and South America. In southern Africa, the species is found in dense shade on rocks, tree trunks, and limbs of saplings in forests of the northern and eastern Transvaal areas and KwaZulu-Natal. Map 227.

Vouchers: *Cholnoky 274; Crosby & Crosby 7893; Pienaar 25; Von Breitenbach 222.*

The fine, slender plants with dull, wide-spreading, distant leaves should place specimens of *F. floribunda*. Sporophytes have not been found in the *Flora* area, but they are borne on short lateral shoots; the seta is ± 4 mm long and carry the short ovoid capsule above the leaves; the peristome is well developed and the operculum is conic-rostrate.

FIG. 162.—**Floribundaria floribunda**: **1.** habit (dry), × 1; **2.** habit (wet), × 3; **3.** part of stem in cross section, × 175; **4.** stem leaf, × 35; **5.** branch leaf, × 35; **6.** basal cells of stem leaf (papillae partly shown), × 175; **7.** upper laminal cells of stem leaf (papillae partly shown), × 350; **8.** stem leaf apex (papillae partly shown), × 175. (1 & 3–7, *Crosby 7540*; 2, *Brenan 3237*.)

LEPTODONTACEAE

Plants medium-sized, forming loose tufts, dark green to yellow-green; corticolous or saxicolous. *Secondary stems* erect, sometimes incurved when dry, generally pinnately branched; branches in single plane; in section central strand absent; paraphyllia present or absent; pseudoparaphyllia present. *Leaves* appressed dry, widespreading wet; broadly ovate; apex rounded or acute to acuminate; margins plane, entire. *Costa* strong, single, extending to midleaf or above. *Upper laminal cells* short, rhombic; alar cells quadrate to transversely rectangular, frequently in large groups.

Autoicous or dioicous. *Perigonia* and perichaetia along erect stems and branches. *Seta* short. *Capsule* exserted, short-cylindrical. *Peristome* double; exostome teeth somewhat irregular, smooth, whitish; endostomes rudimentary. *Operculum* rostrate. *Calyptra* cucullate, somewhat hairy. *Spores* small, granulate.

The family Leptodontaceae presently contains only four genera, two of which occur in the *Flora* area. *Forsstroemia* and *Leptodon* are widely, although sporadically, distributed throughout the world and appear to be of southern hemisphere origin. Both genera are represented in Africa by single species.

Leaf apex acuminate; stems without paraphyllia; plants erect dry . . . . . 1. **Forsstroemia**
Leaf apex obtuse; stems with numerous paraphyllia; plants incurved dry . . . . . 2. **Leptodon**

1. FORSSTROEMIA

Forsstroemia *Lindb.* in Ofvers. Forh. Kongl. Svenska Vetensk.-Akad. 19: 605 (1863); Broth. in Natürl. PflFam., edn 2, 11: 87 (1925); Sim, Bryo. S. Afr. 359 (1926); Stark, J. Hattori Bot. Lab. 63: 145 (1987). Type species: *F. trichomitria* (Hedw.) Lindb.

Plants single or in small tufts; corticolous or saxicolous. *Stems* subdendroid, erect wet or dry; pinnately branched. *Leaves* ovate; acute to acuminate; margins plane, entire to serrulate. *Costa* single, extending to midleaf. *Laminal cells* rhombic, smooth; alar cells in distinct groups.

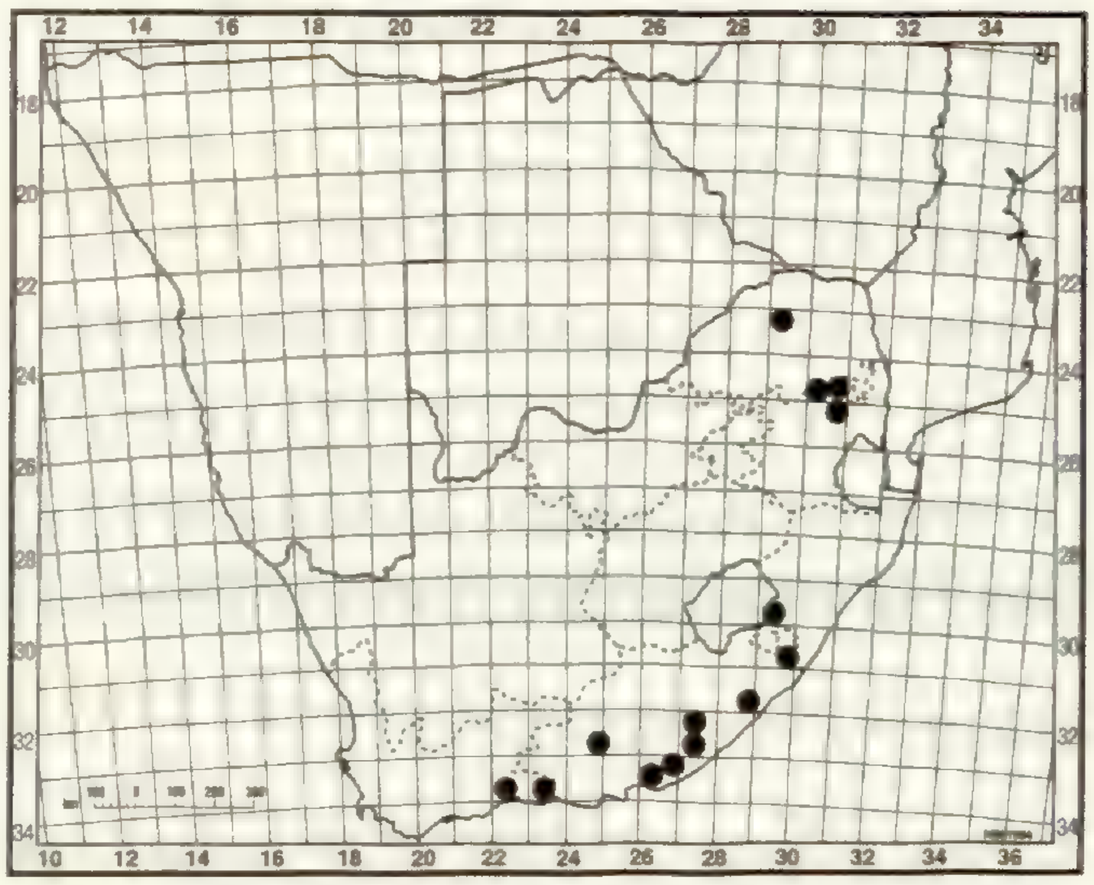
Autoicous. *Seta* short. *Capsule* emergent to exserted. *Peristome* double but with endostomes rudimentary or sometimes absent. *Operculum* conic-rostrate. *Calyptra* cucullate.

A recent revision of *Forsstroemia* (Stark 1987) included all African specimens in *F. producta*, the most widely distributed species. *Forsstroemia* has for some time been treated in the family Cryphaeaceae, but was moved to Leucodontaceae by Manuel (1974), primarily on the basis of a cucullate calyptra. He discounted other differences, such as the presence of pseudoparaphyllia in *Forsstroemia*, and created a new subfamily, Forsstroemioideae, for *Forsstroemia* and two other discordant genera of the Leucodontaceae, *Pseudocryphaea* and *Leucodontopsis*. Although the subfamily provides a better placement for *Forsstroemia*, it is also discordant within Leucodontaceae because of the production of pseudoparaphyllia.

Buck (1980) subsequently moved the three genera and *Leptodon* to Leptodontaceae citing similarities in several gametophytic and sporophytic characters. *Leptodon*, however, produces numerous paraphyllia along its stem, while *Forsstroemia*, *Pseudocryphaea* Britt. and *Leucodontopsis* Ren. & Card. lack paraphyllia. A relationship between *Forsstroemia* and *Leptodon* undoubtedly exists. However, a firmer circumscription of Leptodontaceae is needed for a proper assessment of other genera that belong here.

Forsstroemia producta *(Hornsch.) Par.*, Ind. Bryol. 498 (1896); Broth. in Natürl. PflFam., edn 2, 11: 88 (1925); Sim, Bryo. S. Afr. 359 (1926); Stark, J. Hattori Bot. Lab. 63: 163 (1987). Neotype: South Africa, Cape Prov., Katberg Forest Reserve, *Crosby & Crosby 7974* (MO), vide Stark (1987).

Pterogonium productum Hornsch. in Linnaea 15: 138 (1841). *Neckera producta* (Hornsch.) C. Müll., Syn. musc. frond. 2: 94 (1850). *Lasia producta* (Hornsch.) Jaeg. in Ber. Thätigk. St. Gallischen Naturwiss. Ges. 1875–1876: 204 (1877).



MAP 228.—**Forsstroemia producta**

Plants medium-sized, forming tufts or rarely scattered and gregarious, green to yellow-green; corticolous to saxicolous. *Primary stems* creeping; secondary stem erect, 15–40 mm long, branching ± regular in a single plane, pinnate; in section oval, central strand absent, inner cortical cells thin-walled, hyaline, in 4–6 rows, outer cortical cells thick-walled, yellow, in 2 or 3 rows; paraphyllia absent; pseudoparaphyllia narrowly foliose. *Leaves* crowded, widespreading wet, appressed dry; stem leaves ovate, 1.0–1.8 mm long; acute to acuminate; occasionally twisted at apex; rounded at base; margins plane, entire to weakly serrulate; branch leaves smaller but similar in other respects to stem leaves. *Costa* single, extending to midleaf or above, smooth; in section elliptical, consisting of three rows of undifferentiated cells. *Upper laminal cells* rhombic to quadrate, homogeneous, 11–20 µm long, 6–10 µm wide, walls thickened, smooth; basal cells not strongly differentiated, rectangular to fusiform, greenish, walls thickened, smooth; alar cells forming distinct groups, quadrate to transversely rectangular, green, walls thickened.

Perigonia gemmate. *Perichaetia* strongly differentiated; leaves lanceolate-acuminate, 2–3 mm long, leaf cells linear and ± sigmoid. *Seta* 1–3 mm long, yellow, smooth. *Capsule* emergent to shortly exserted, ± erect, short-cylindrical, 1.0–1.5 mm long, smooth, yellow-brown; exothecial cells irregular-rectangular, walls thin, cells at mouth darker, quadrate to transversely rectangular; annulus absent; neck cells not differentiated; stomata absent. *Peristome* double, light yellow; exostome teeth fragile and irregular, linear, inflexed and closed wet, sigmoid and incurved dry; ± smooth cleft and perforated, with median zigzag line, 100–110 µm high; endostome segments rudimentary or sometimes absent with age. *Operculum* conic-rostrate, erect to curved. *Calyptra* cucullate, 3 mm long, weakly hairy. *Spores* rounded, 12–20 µm, granulate, brownish. Fig. 163: 1–11.

Forsstroemia producta is a widespread species found on trees and boulders in eastern North America and Mexico, central South America, eastern and southern Africa, eastern Australia, Tasmania, Korea and China. In southern Africa the species is generally collected on trees and saplings in forests of the northern and eastern Transvaal areas, KwaZulu-Natal, and

FIG. 163.—**Forsstroemia producta** (1–11): **1.** habit (dry), × 1.5; **2.** stem in cross section (cells partly shown), × 175; **3.** leaf, × 32; **4.** leaf in cross section, × 175; **5.** basal leaf cells, × 160; **6.** upper laminal cells, × 350; **7.** leaf apex, × 160; **8.** perichaetial leaf, × 32; **9.** part of capsule mouth with peristome teeth, × 175; **10.** calyptra, × 32; **11.** spore, × 700. **Leptodon smithii** (12–24): **12.** habit (dry), × 1; **13.** habit (wet), × 1; **14.** part of stem in cross section, × 175; **15.** leaves, × 32; **16.** leaf in proximal cross section, × 175; **17.** leaf in distal cross section, × 175; **18.** basal leaf cells, × 160; **19.** cells at leaf apex, × 160; **20.** paraphyllia, × 160; **21.** perichaetial leaf, × 35; **22.** part of capsule mouth with peristome (papillae partly shown), × 175; **23.** operculum, × 35; **24.** spore, × 700. (1–11, *Crosby 7915*; 12 & 13, *Crosby 7925*; 14–21, *Crosby 8054*; 22–24, *Smook 3957*.)

the eastern, southern, central and southwestern Cape regions. Map 228.

Vouchers: *Crosby & Crosby 7515, 7974; Magill 3227, 6781; Smook 3960.*

Plants of *F. producta* have a long-creeping primary stem from which erect secondary stems arise. The branched secondary stems grow out perpendicularly from the substrate and are quite distinctive when growing alone on small saplings. The plants generally have many obvious perichaetia along the erect stems and frequently several sporophytes per stem. The leaves have a single costa that extends to midleaf or beyond and this should separate *F. producta* from all similar taxa except perhaps *Cryphaea exigua*. The immersed capsules, narrower leaves and toothed leaf margins of the latter separate it from *F. producta*.

2. LEPTODON

Leptodon *Mohr*, Observ. bot. 27 (1803), nom. cons.; Broth. in Natürl. PflFam., edn 2, 11: 179 (1925); Sim, Bryo. S. Afr. 398 (1926); Sainsb., N. Zeal. mosses 360 (1955). Type species: *L. smithii* (Hedw.) Web. & Mohr.

Plants medium-sized, in loose tufts, green; saxicolous or corticolous. *Stems* strongly curved when dry, bipinnately branched; in section central strand absent; paraphyllia numerous. *Leaves* oval; obtuse; weakly decurrent at base; margins plane, entire. *Laminal cells* short, weakly thickened, smooth; basal and alar cells not strongly differentiated.

Dioicous. *Seta* short. *Capsule* just exserted, urn short ellipsoidal. *Peristome* double; exostome teeth whitish, papillose; endostomes rudimentary. *Operculum* curved-rostrate. *Calyptra* conical, hairy.

Traditionally placed in the Neckeraceae, *Leptodon* is treated in Leptodontaceae on the basis of its habit; whitish, double peristome; split, conical calyptra; absence of a central strand in the stem; and foliaceous pseudoparaphyllia. The placement of the family in a linear sequence may seem remote from it former placement, but this family should be viewed as an intermediate between Leucodontaceae/Cryphaeaceae on the one hand and Neckeraceae on the other.

Leptodon smithii *(Hedw.) Web. & Mohr*, Ind. Mus. Pl. Crypt. 2 (1803); Broth. in Natürl. PflFam., edn 2, 11: 180 (1925); Sim, Bryo. S. Afr. 398 (1926); Smith, Moss Fl. Brit. Irel. 504 (1978). Type: United Kingdom.

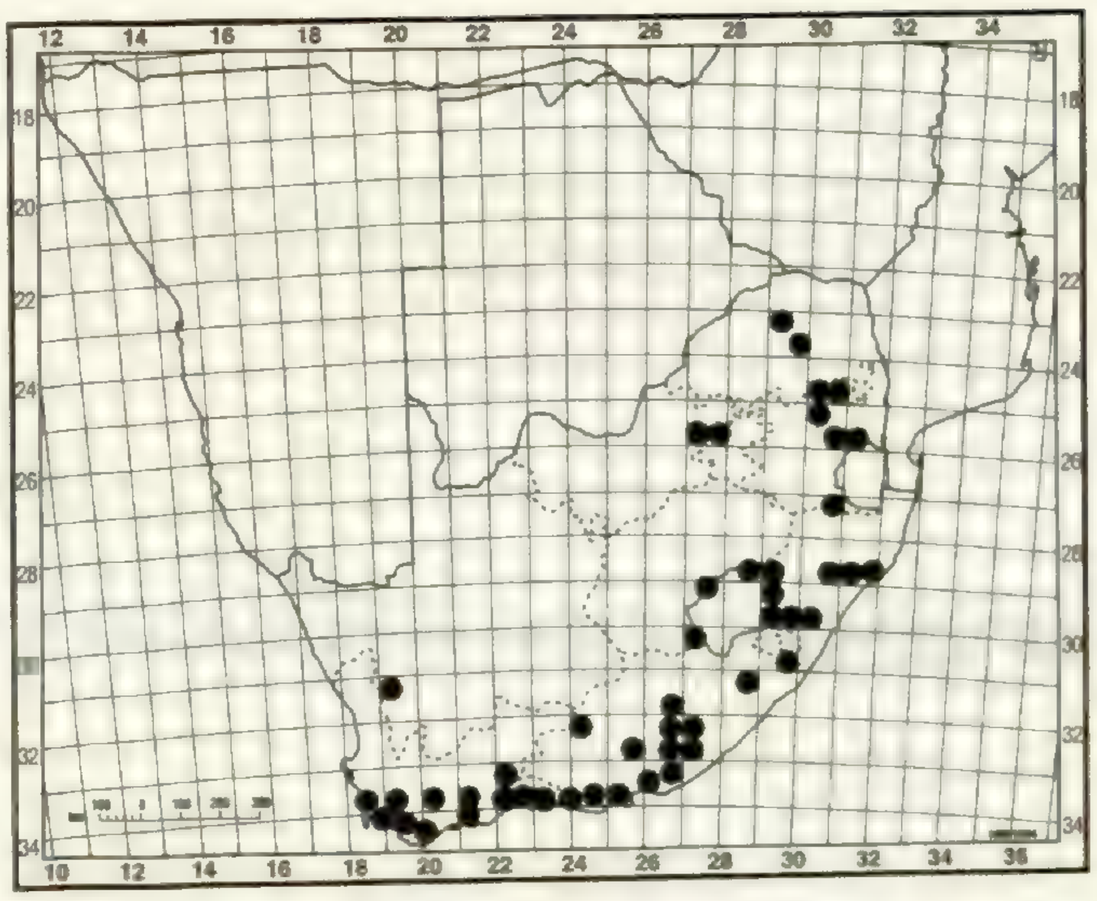
Hypnum smithii Dicks. ex Hedw., Sp. musc. frond. 264 (1801). *Neckera smithii* (Hedw.) C. Müll., Syn. musc. frond. 2: 118 (1850).

Plants medium-sized, gregarious or forming loose tufts, dark green to green or yellow-green; corticolous or saxicolous. *Primary stems* creeping; secondary stem erect, 20–50 mm long, branching regular above stipe, dense, twice-pinnate in single plane; in section oval, central strand absent, inner cortical cells thin-walled, hyaline, in 5 or 6 rows, outer cortical cells smaller, yellow, thick-walled, in 3–5 rows; axillary hairs numerous, to 9 per axil, 3 cells long, basal cell brownish; paraphyllia numerous, branched, multicellular but not foliose, smooth; pseudoparaphyllia foliose. *Leaves* evenly spaced, spreading wet, weakly crisped dry; stem leaves ovate to elliptical, 1–2 mm long; obtuse to acute; rounded and narrowed to insertion, weakly decurrent; margins plane, entire; branch leaves smaller but similar in other respects to stem leaves, 0.5–1.0 mm long. *Costa* single, extending to midleaf or ending below apex, ventral and dorsal surface smooth, cells elongate; in section elliptical and bulging dorsally, cells undifferentiated, in three rows. *Upper laminal cells* quadrate to rectangular or rhombic to transversely rectangular, somewhat heterogeneous, 15–32 µm long, 15 µm wide, walls weakly thickened, smooth; basal cells rec-

tangular, to 40 µm long, 10–15 µm wide, greenish, walls incrassate, ± wavy, smooth; alar cells quadrate, yellowish, walls ± incrassate.

Perigonia gemmate; perigonial leaves broadly ovate-acuminate, 1.0–1.2 mm long. *Perichaetia* strongly differentiated; perichaetial leaves lanceolate-subulate, 3.0–3.5 mm long, leaf cells linear and somewhat sigmoid, rectangular at margins, thickened. *Seta* 0.5–2.0 mm long, yellow, smooth; vaginula sometimes as long as seta, hairy, 0.6 mm long. *Capsule* exserted, erect, short ellipsoid, 1.2–1.6 mm long, smooth, brownish; neck not differentiated; exothecial cells rectangular, somewhat irregular, walls weakly thickened, cells at mouth quadrate to transversely rectangular; annulus absent; stomata absent. *Peristome* double, whitish to yellowish; exostome teeth narrowly triangular, inflexed dry, erect wet, weakly papillose, with median zigzag line, 250–280 µm high; endostome segments and cilia absent; basal membrane low, rudimentary. *Operculum* curved-rostrate, 0.5 mm long. *Calyptra* campanulate-mitrate, 2.0–2.5 mm long, hairy. *Spores* rounded, 15–20 µm, granulate, brown. Fig. 163: 12–24.

Leptodon smithii is found on bark and rock in woodlands and forests of Europe, southwestern Asia, Macaronesia, northern, eastern and southern Africa, southern South America and the Juan Fernández islands, Australia and New Zealand. In the *Flora* area, the species is found in the northern, central and eastern Transvaal areas, Zululand, KwaZulu-Natal, eastern Free State and the eastern, southern, central, southwestern, and northwestern Cape regions. Map 229.



MAP 229.—**Leptodon smithii**

Vouchers: *Crosby & Crosby 8053; Esterhuysen 21628; Goldblatt 2114a; Magill 3375; Van Rooy & Perold 3812.*

The pronounced curving of the stems and branches when dry help to identify the species in the field. When wet, the stems are erect from the substrate and branches spread outward in a single plane. The stem is covered with numerous paraphyllia, a character which separates *L. smithii* from mosses with similar habits, e.g. *Forsstroemia* and *Pterogonium*.

NECKERACEAE

The family Neckeraceae contains 12 genera found in forests and woodlands in temperate and tropical areas. Only one genus is found in the *Flora* area.

NECKERA

Neckera *Hedw.*, Sp. musc. frond. 200 (1801); Broth. in Natürl. PflFam., edn 2, 11: 184 (1925); Sim, Bryo. S. Afr. 400 (1926). Lectotype: *N. pennata* Hedw.

Plants small to large, creeping, green to yellow green or golden; corticolous or saxicolous. *Stems* appressed to substrate, densely leaved, flattened; central strand absent; paraphyllia filamentous or absent; pseudoparaphyllia filamentous or narrowly foliose. *Leaves* strongly complanate, undulate, oblong-acute; margins plane, entire to serrulate. *Costa* short and double. *Laminal cells* linear, smooth; basal cells not distinct; alar cells in small groups.

Autoicous. *Perigonia* and perichaetia along stems or branches. *Seta* short or long, smooth. *Capsule* immersed, erect, oblong. *Peristome* double, incomplete; exostome teeth narrow, striate at base; endostome segments well developed above low basal membrane, cilia absent. *Operculum* rostrate. *Calyptra* cucullate, smooth. *Spores* small, round.

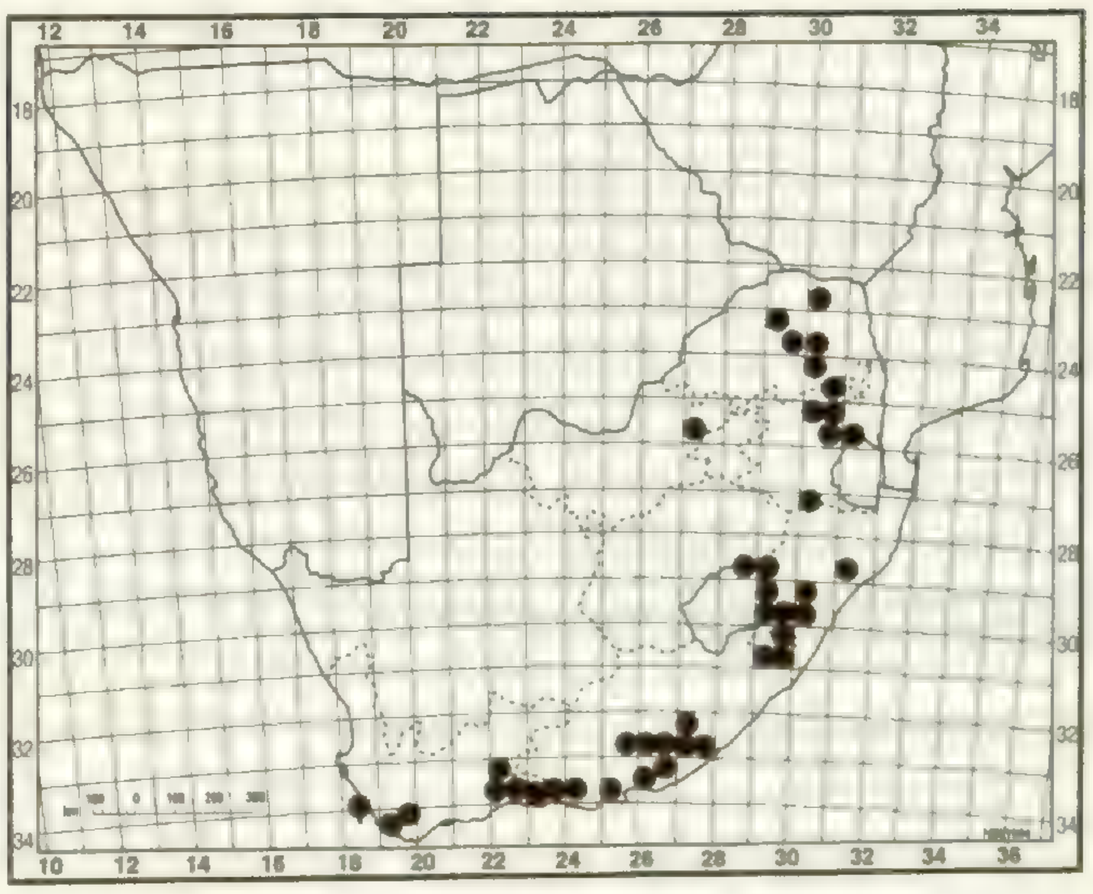
Neckera, a genus of about 90 species, is found in temperate and tropical forests. Plants can be recognized by their flattened appearance and undulate leaves.

Neckera valentiniana *Besch.* in Ann. Sci. Nat. Bot. 6, 10: 273 (1880); Broth. in Natürl. PflFam., edn 2, 11: 185 (1925); Sim, Bryo. S. Afr. 400 (1926). Type: Réunion, Paves Saint-Leu, *Valentin s.n.*, 1876.

Plants medium-sized to large, forming mats, green to yellow-green; corticolous or saxicolous. *Stems* flattened, 40–60 mm long, branching irregular, ± scattered; in section oval, central strand absent, inner cortical cells thin-walled, hyaline, in 6–8 rows, outer cortical cells thick-walled, yellow-brown, in 3 or 4 rows. *Leaves* evenly spaced, complanate, weakly crisped at apex, undulate, somewhat falcate; oblong-ovate, 2–3 mm long; acute; rounded at base; margins plane, entire to serrulate above. *Costa* short and double, smooth. *Upper laminal cells* linear-fusiform, homogeneous, 40–75 µm long, 3–6 µm wide, walls thin, smooth; basal cells not strongly differentiated, greenish, walls thickened, smooth; alar cells in small groups, quadrate, yellowish, walls thickened.

Perigonia gemmate; perigonial leaves ovate-acuminate, 1.0–1.5 mm long. *Perichaetia* strongly differentiated; perichaetial leaves elliptical-acuminate, spreading at tips, to 4 mm long, leaf cells linear, thin-walled. *Seta* 0.5–1.0 mm long, yellow-brown, smooth. *Capsule* exserted, erect, short-cylindrical, 1.5 mm long, smooth, yellow-brown; exothecial cells ± irregular, quadrate to rectangular, walls weakly thickened; cells at mouth smaller, quadrate, thickened; stomata phaneropore, on lower urn. *Peristome* double and incomplete, yellow; exostome teeth linear, reflexed wet, inflexed dry, with median zigzag line, smooth above, weakly striate at base, 500 µm high; endostome segments linear above very low basal membrane, as long as teeth, smooth; cilia absent. *Operculum* obliquely rostrate. *Calyptra* cucullate, smooth. *Spores* rounded, 18–25 µm, granulate, green. Fig. 164.

Neckera valentiniana forms large mats on trees and rocks in forests of southern Africa and



MAP 230.—**Neckera valentiniana**

the East African islands. In the *Flora* area the species is found in wet forests of the northern, central and eastern Transvaal areas, Zululand, KwaZulu-Natal and the eastern, southern and southwestern Cape regions. Map 230.

Voucher: *Esterhuysen 25043; Magill 5725, 6264; Oliver 6787; Von Breitenbach 221; Van Rooy 1062.*

The large green mats and stems with complanate, undulate leaves quickly identify this species in the *Flora* area. The plants are gametophytically similar to the widespread species *N. pennata* Hedw., but differ in the well developed endostomal segments produced by *N. valentiniana*. In addition, the numerous paraphyllia produced by *N. valentiniana*, while not unique, are generally absent in *N. pennata*.

FIG. 164.—**Neckera valentiniana**: **1.** habit (dry, undulations partly shown), × 1.5; **2.** part of secondary stem with branch and sporophyte (wet, undulations partly shown), × 3; **3.** leaf, × 35; **4.** basal leaf cells (left side), × 175; **5.** upper laminal cells at right margin, × 50; **6.** leaf apex, × 175; **7.** paraphyllium, × 175; **8.** perichaetial leaf, × 35; **9.** part of capsule mouth with peristome, × 87; **10.** spore, × 700. (1, *Magill 6264*; 2, *Von Breitenbach 221*; 3–10, *Van Rooy 1277*.)

THAMNOBRYACEAE

Plants small to large or occasionally robust, dendroid, branches occasionally attenuate, dark green to yellow green or golden; corticolous or saxicolous. *Primary stems* long-creeping, appressed to substrate, naked; secondary stems erect and perpendicular to substrate; in section central strand small or absent; paraphyllia absent; pseudoparaphyllia narrowly foliose. *Leaves* concave, ovate to oblong; acute; margins plane, dentate. *Costa* strong and single. *Laminal cells* elongate or sometimes rounded, smooth, sometimes pitted; basal cells distinct; alar cells in small groups and not strongly differentiated.

Dioicous. *Perigonia* and perichaetia along stems or branches. *Seta* long, smooth. *Capsule* exserted, erect. *Peristome* double, incomplete; exostome teeth narrow, striate below; endostome segments well developed above basal membrane, cilia generally absent. *Operculum* rostrate. *Calyptra* cucullate, smooth or with a few hairs. *Spores* small, round.

The recently segregated family Thamnobryaceae contains six genera found in forests and woodlands of tropical and subtropical regions. Three genera are found in the *Flora* area.

1 Upper laminal cells irregularly rounded-quadrate . . . . . 1. **Pinnatella**
1 Upper laminal cells rhombic to rhomboidal or fusiform:
  2 Peristome complete, cilia present; leaves with marginal teeth made up of more than one cell . . . . . 2. **Porothamnium**
  2 Peristome incomplete, cilia absent; leaves with marginal teeth or serrations made up of single projecting cells . . . . . 3. **Porotrichum**

1. PINNATELLA

Pinnatella *Fleisch.* in Hedwigia 45: 79 (1906); Broth. in Natürl. PflFam., edn 2, 11: 195 (1925); Potier de la Varde in Mém. Soc. Sci. Nat. Cherbourg 42: 151 (1936); Enroth in Acta Bot. Fennica 151: 12 (1994). Lectotype species: *P. kuehliana* (Bosch & Sande Lac.) Fleisch.

Plants small, dendroid, green; saxicolous. *Secondary stems* erect, branched above leafy stipe; branching mostly complanate. *Leaves* concave, somewhat plicate when dry, ovate; obtuse; strongly costate; branch leaves smaller. *Leaf cells* rounded-quadrate, somewhat irregular, thickened; alar cells not differentiated.

Dioicous. *Seta* short. *Capsule* exserted. *Peristome* double.

A genus of 15 species found in the wet tropical and subtropical forests of Africa, America, Asia and Australia. A single species is known from continental Africa.

Pinnatella minuta *(Mitt.) Broth.* in Natürl. PflFam. 1,3: 857 (1906); Enroth in Acta Bot. Fennica 151: 12 (1994). Holotype: Cuba, *Wright s.n.* (NY).

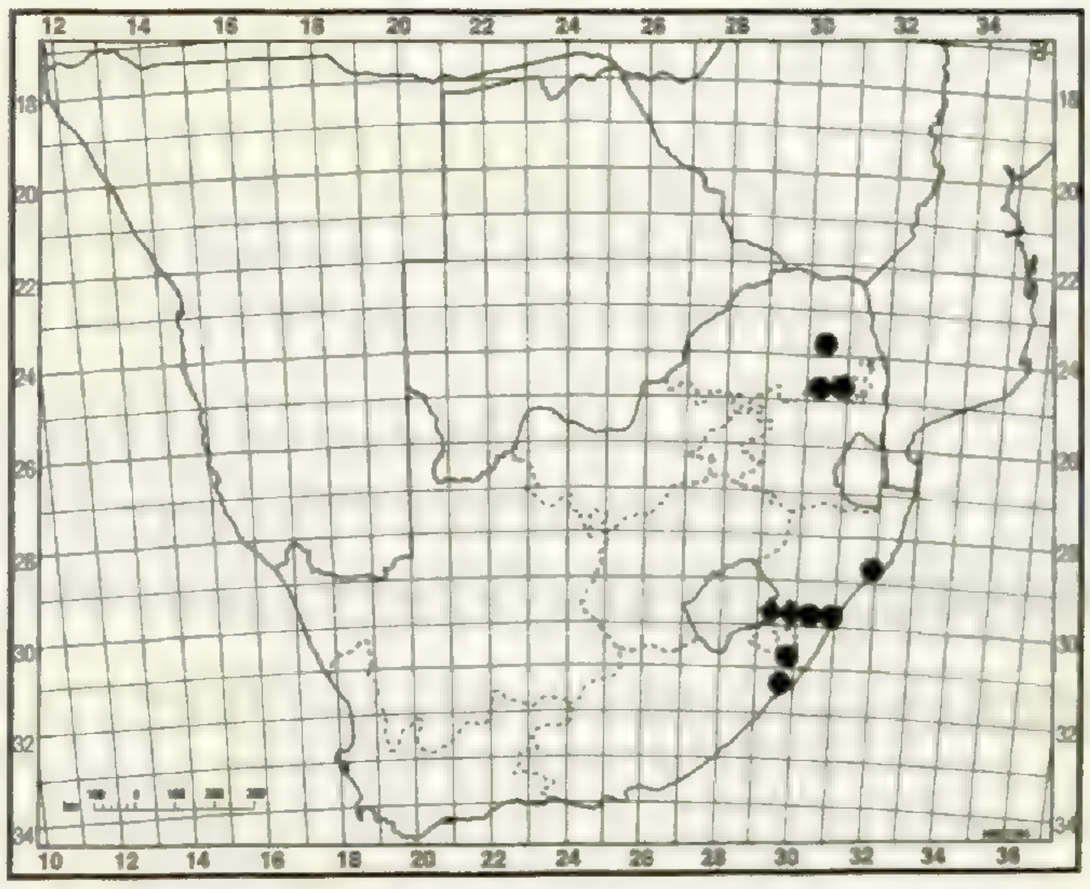
Porotrichum oblongifrondeum Broth. in Bot. Jahrb. Syst. 20: 200 (1894). *Pinnatella oblongifrondea (Broth.) Broth.* in Natürl. PflFam. 1,3: 857 (1906). Lectotype: Tanzania, Usambara, Kwa Mshusa-Station, trockene Hochwälder bei Msingo, *Holst 9193a* (H).

Plants small to medium-sized, scattered or forming loose colonies, green; saxicolous or corticolous. *Primary stems* creeping; secondary stems erect, 8–12 mm long, dendroid, branching irregular and ± complanate above stipe; in section oval, central strand absent, inner cortical cells thick-walled, yellow, in 6–8 rows, outer cortical cells somewhat smaller, thick-walled, yellow-brown; paraphyllia absent; pseudo-

paraphyllia foliose. *Leaves* evenly spaced, widespreading wet, somewhat crisped and incurved dry, concave; stem leaves ovate to broadly ovate, 1 mm long; obtuse, rounded-obtuse or acute; rounded to cordate at base; margins plane, entire below, weakly serrulate at apex; branch leaves ovate or ovate-elliptical, 0.4–0.6 mm long; obtuse to rounded or broadly acute; rounded at base; margins plane or erect, entire below, weakly serrulate at apex. *Costa* single, subpercurrent, smooth, frequently spurred above; in section bulging dorsally, consisting of 3 or 4 rows of undifferentiated, thickened cells. *Upper laminal cells* irregularly rounded-quadrate, homogeneous, 6–12 µm long, walls thickened, smooth on both surfaces; basal cells oblong, forming distinct group, 30–38 µm long, 5–7 µm wide, walls thickened, smooth; basal marginal cells small, quadrate, in 1 or 2 rows; alar cells not differentiated.

Sporophyte not known from the study area. Fig. 165: 1–8.

Pinnatella minuta is the only representative of the genus in the Neotropics, sub-Saharan Africa and the East African islands, and is also known from a single locality in the Nilgiri Mountains of southern India. In the *Flora* area the species is rare, having been collected only twice in KwaZulu-Natal. Both of the South African specimens were sterile and appear to have been collected on rock, although this is not indicated on the labels. Map 231.



MAP 231.— ♦ **Pinnatella minuta**
● **Porotrichum usagarum**

Vouchers: *Sim 10327, 10333.*

The plants are most easily identified by their small dendroid habit, ovate leaves with obtuse apices, strong, single costa and short leaf cells. The plants are considerably smaller than all of the *Porotrichum* species, which share a similar habit.

2. **POROTHAMNIUM**

Porothamnium *Fleisch.*, Musc. Buitenzorg 3: 927 (1908); Broth. in Natürl. PflFam., edn 2, 11: 198 (1925); De Sloover in Bull. Jard. Bot. Belg. 53: 97–152 (1983). Type species: not selected.

Plants large, dendroid, in loose colonies; corticolous or saxicolous. *Primary stems* long-creeping, appressed to substrate; secondary stems erect, pinnately branched above stipe. *Leaves* ovate to broadly ovate-elliptical; apex acute to acuminate; margins plain, dentate. *Costa* single, extending to upper leaf, frequently ending in dorsal spine.

Dioicous. *Capsule* exserted, erect. *Peristome* double, complete; exostome teeth broad, striate; endostome segments broad, cleft and perforated along keel; cilia 3, as long as segments. *Operculum* rostrate. *Calyptra* cucullate, smooth. *Spores* small, granulate.

A genus of about 30 species found in wet forests of the Americas, Asia and Africa. Sim (1926) placed the species of *Porotrichum* in this genus but recent research by De Sloover (1983) has indicated that differences in peristome structure separate the two genera. In the *Flora* area the larger size and strong marginal leaf dentation of *Porothamnium* also separate it from *Porotrichum*.

Porothamnium stipitatum *(Mitt.) Touw ex De Sloover* in Bull. Jard. Bot. Belg. 53: 134 (1983). Type: Fernando Po, *Mann s.n.*

Trachyloma stipitatum Mitt. in J. Linn. Soc., Bot. 7: 156 (1864). .

Hypnum hildebrandtii C. Müll. in Linnaea 40: 287 (1876). *Thamnium hildebrandtii* (C. Müll.) Jaeg. in Ber. Thätigk. St. Gallischen Naturwiss. Ges. 1877–1878: 467 (1880). *Porothamnium hildebrandtii* (C. Müll.) Fleisch., Musc. Buitenzorg 3: 926 (1908). Type: Comoros, Johanna, *Hildebrandt s.n.*, 1828 (BM, PC).

Neckera pterops Rehm. in Geh., Rev. Bryol. Lichénol. 5: 70 (1878), nom. nud. *Porotrichum pterops* Rehm. ex Par., Index Bryol. suppl. 283 (1900), nom. nud. Type: not given, but *Rehmann 329*, fide Müller in Hedwigia 38: 130 (1899).

Thamnium afrum C. Müll. in Hedwigia 38: 129 (1899). Type: South Africa, Natal, Inanda, *Wood s.n.* (Hb. Mac-Owan).

Plants large, frequently covering extensive areas, dark green; saxicolous or corticolous, rarely terricolous. *Primary stems* creeping; secondary stems erect, to 120 mm long, stipe to 60 mm long, branches dense above stipe, branching simple to pinnate; in section round, central strand small and dense in erect stems, inner cortical cells small, thin-walled, yellowish, outer cortical cells smaller, ± thick-walled, brown. *Leaves* flattened, spreading, weakly crisped when dry; stem leaves broadly ovate to oblong-ovate, (1.0–)1.5–2.5(–3.0) mm long; acute to broadly acute; narrowed to insertion; margins plane, dentate, teeth multicellular; branch leaves similar to stem leaves but somewhat smaller. *Costa* single, extending to midleaf or above, smooth but terminating in a single dorsal tooth; in section bulging dorsally, in 3 rows of thickened, undifferentiated cells. *Upper laminal cells* irregularly rhomboidal, somewhat sigmoid, homogeneous, 35–50 µm long, 8–12 µm wide, walls weakly thickened, smooth; basal cells rectangular to rhomboidal, 40–75 µm long, 8–12 µm wide, walls weakly thickened, smooth; alar cells not differentiated.

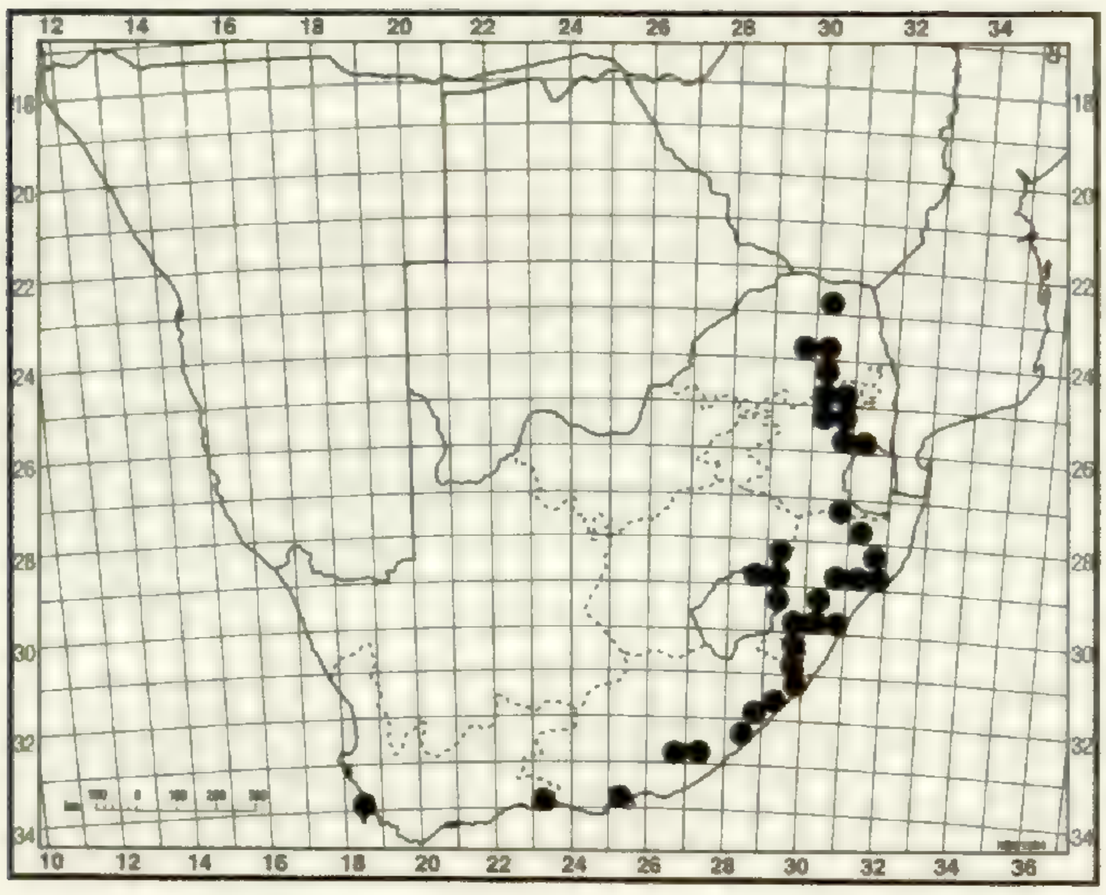
Perigonia axillary on branches, gemmate; perigonial leaves ovate, cuspidate, 1.0 mm long. *Perichaetia* along branches, obvious, green; perichaetial leaves oblong-acuminate, sheathing below, spreading at tips, to 2.5 mm long, leaf cells rhomboidal, thickened. *Seta* 15–25 mm long, red-brown, smooth. *Capsule* long-exserted, erect to inclined, ovoid, 2–3 mm long, smooth, red-brown, urn cylindrical, neck not differentiated; exothecial cells quadrate to rectangular or hexagonal, walls thickened, cells at mouth quadrate, strongly thickened, darker. *Peristome* double, yellow-brown; exostome teeth triangular, inflexed wet, erect dry, striate with median zigzag line, to 500 µm high; endostome segments above high basal membranes lanceolate and perforated or broad and cleft with diverging tips, shorter than teeth, weakly granulate; cilia present, linear, shorter than segments, weakly granulate. *Operculum* rostrate, 1 mm long. *Calyptra* cucullate, 2 mm long, smooth. *Spores* rounded, 9–15 µm, weakly granulate, brownish. Fig. 165: 9–17.

This species is found in moist forests of northern South America, sub-Saharan Africa, and the East and West African islands. In the *Flora* area *P. stipitatum* is found on rocks and bark in the forests of the northern and eastern Transvaal areas, Swaziland, Zululand, KwaZulu-Natal and the eastern, southern and south-western Cape regions. Map 232.

Vouchers: *Brenan M2845, Crosby & Crosby 9207; Magill 5127, 6023; Van Rooy 1783.*

Gametophytically the relatively large size, dark green colour, and strongly dentate leaf margins identify this species. The leaf dentations are large enough to be seen easily with a hand lens and are made up of 2–4 cells each.

FIG. 165.—**Pinnatella minuta** (1–8): **1.** habit (dry), × 1; **2.** habit (wet), × 5; **3.** part of stem in cross section, × 175; **4.** stem leaf, × 35; **5.** branch leaf, × 35; **6.** stem leaf base (right side), × 175; **7.** upper laminal cells of stem leaf, × 700; **8.** stem leaf apex, × 175. **Porothamnium stipitatum** (9–17): **9.** habit (dry), × 1; **10.** part of stem with branch and sporophytes (wet), × 1.2; **11.** part of stem in cross section, × 175; **12.** stem leaf, × 35; **13.** branch leaf, × 35; **14.** upper laminal cells of stem leaf at left margin, × 350; **15.** perichaetial leaf, × 18; **16.** part of capsule mouth with peristome (papillae partly shown), × 87; **17.** spore, × 700. (1–8, *Sim 10327*; 9, *Brenan 3351*; 10, *Sim PRE-CH9914*; 11–17, *Sim PRE-CH9901*.)



MAP 232.—**Porothamnium stipitatum**

The species is separated from *Porotrichum* by its perfect peristome with striate teeth, broad segments and well-developed cilia.

Insufficiently known species

Porothamnium capense (Broth. & Dix.) Sim, Bryo. S. Afr. 404 (1926). *Thamnium capense* Broth. & Dix. in Bull. Torrey Bot. Club 43: 71 (1916). Type: In packing from Cape Town, 710. Communicated by G. Webster (BM!). The specimen is sterile and consists of a single, weakly branched creeping stem with leaves sharply serrate throughout and rounded-hexagonal leaf cells and a tooth at the end of the costa. De Sloover (1983) suggested *Thamnobryum* Nieuwl. as a possible placement; Enroth (1991) subsequently made that combination—*T. capense* (Broth. & Dix.) Enroth. The stem seemed more reminiscent of *Ectropothecium* Mitt., but since the plants have not been rediscovered and the collection site is unknown, the species is not formally treated here.

3. **POROTRICHUM**

Porotrichum *(Brid.) Hampe* in Linnaea 32: 154 (1863); Broth. in Natürl. PflFam., edn 2, 11: 196 (1925); Bartram in Fieldiana, Bot. 25: 284 (1949); De Sloover in Bull. Jard. Bot. Belg. 53: 97–152 (1983). Lectotype species: *P. longirostre* (Hook.) Mitt.

Plants large, in loose colonies; corticolous, saxicolous or terricolous. *Primary stems* long-creeping, appressed to substrate; secondary stems erect, pinnately branched above long stipe. *Leaves* ovate to elliptical; apex acute to acuminate; margins plain, serrate above, entire below. *Costa* single, extending to upper leaf, frequently ending in dorsal spine.

Dioicous. *Capsule* exserted, erect. *Peristome* double; exostome teeth narrow, papillose to striate below; endostome segments narrow, perforated, as long as teeth, cilia absent. *Operculum* rostrate. *Calyptra* cucullate. *Spores* papillose.

A genus of over 50 species found in the wet temperate to tropical areas of Central and South America, Africa and Asia. The separation of this genus from *Porothamnium* follows the treatment of De Sloover (1983) and is based on several easily observable gametophytic characters and significant differences in the peristomes of the two genera.

Gametophytically the African species placed in *Porotrichum* are smaller plants, dark green to yellow-green in colour, and have serrate to denticulate upper leaf margins. The differences exhibited by the peristomes of *Porotrichum* and *Porothamnium* are reminiscent of the differences between the Hookeriaceous and Daltoniaceous peristomes (Whittemore & Allen 1989).

The peristome teeth of the African *Porotrichum* species are narrow and papillose to papillose-striate below while the African *Porothamnium* species have broad teeth that are characterized as striate throughout. The endostome segments are narrow and perforated and the cilia are absent or rudimentary in these species of *Porotrichum*, while *Porothamnium* has broad, cleft or perforated segments and well-developed cilia.

1 Leaf cells short, rhomboidal; leaves broadly elliptical, apex acute, margins denticulate to midleaf or below; plants green to dark green . . . . . 1. *P. usagarum*
1 Leaf cells longer, rhomboidal to fusiform; leaves ovate to ovate-elliptical, apex short acuminate, margins serrate above; plants green to yellow-green:

2 Costa disappearing in upper leaf, not ending in dorsal spine; common in moist forests . . . . . 2. *P. madagassum*
2 Costa ending in short dorsal spine; rare . . . . . 3. *P. elongatum*

1. **Porotrichum usagarum** *Mitt.* in J. Linn. Soc., Bot. 22: 315 (1886); Enroth in Ann. Bot. Fenn. 28: 197–200 (1991); Enroth & Hodgetts in J. Bryol. 19: 140 (1996). Lectotype: Tanzania, Usagara Mountains, *Hannington s.n.* (NY; H, S, isolecto.) *fide* Enroth (1991).

Porotrichum molliculum Broth. in Bot. Jahrb. Syst. 24: 257 (1897). *Thamnium molliculum* (Broth.) Kindb. in Hedwigia 41: 220 (1902). *Porothamnium molliculum* (Broth.) Fleisch. in Broth. in Natürl. PflFam., edn 2, 11: 199 (1925). Syntypes: Tanzania, *Volkens s.n.*, 1941; *Scott Elliott 260.*

Porotrichum natalense C. Müll. in Hedwigia 38: 129 (1899). *Porothamnium natalense* (C. Müll.) Fleisch., Musc. Buitenzorg 3: 926 (1908). *Thamnium natalense* (C. Müll.) Kindb. in Hedwigia 41: 239 (1902). Type: Natal, Inanda, *Rehmann 334* (PRE).

Thamnium penniforme (‘*pennaeforme*’) Kindb. var. *brachyphyllum* Dix. in Trans. Roy. Soc. South Africa 18: 257 (1929). Type: Transkei, Port St Johns, *Wager 954* (PRE).

Plants medium-sized, in loose colonies, dark green and somewhat glossy; corticolous or saxicolous. *Primary stems* long-creeping; secondary stems erect, to 120 mm long, branching somewhat irregular above stipe; in section round, central strand absent, inner cortical cells thin-walled, hyaline, in 8–10 rows, outer cortical cells smaller, thick-walled, yellow-brown, in 8–12 rows. *Leaves* ± crowded, spreading wet, appressed dry; stem leaves ovate to ovate-elliptical, 1.5–3.0 mm long; apex acute or acuminate, apiculate on larger, broader leaves; narrowed to insertion; margins plane, denticulate; branch leaves ovate to elliptical, 1.0–1.5 mm long; acute; narrowed to insertion; margins plane, denticulate, cells not differentiated. *Costa* single, extending to midleaf or above, smooth, ending distally in short dorsal spine, ventral and dorsal surface smooth; in section elliptical, cells not strongly differentiated. *Upper laminal cells* rhombic to rhomboidal, homogeneous, 12–22 µm long, 5–6 µm wide, walls somewhat thickened, smooth; basal cells rectangular, 12–40 µm long, 5–6 µm wide, hyaline, walls thickened, smooth; alar cells not differentiated.

Perigonia on stems and branches, gemmate; perigonial leaves ovate. *Perichaetia* along stem and branches, green; perichaetial leaves oblong-acuminate, 1.2–1.8 mm long. *Seta* 10–15 mm long, yellow-brown, smooth. *Capsule* exserted, erect, ellipsoid, 2.0–2.5 mm long, smooth, brown. *Peristome* double, brown; exostome teeth linear, papillose, 600–800 µm high; endostome segments linear above low basal membrane, as long as teeth, papillose, cilia absent. *Operculum* long-rostrate, 1.5 mm long. *Calyptra* cucullate, smooth or with a few hairs. *Spores* rounded, 12–15 µm, granulate, brown. Fig. 166: 10–14.

This species is known from moist forests of central, eastern and southern Africa, Madagascar and the East African islands. In the *Flora* area *P. usagarum* is infrequently collected in the forests of Zululand and KwaZulu-Natal, and has rarely been found in the northern and eastern Transvaal areas and the eastern Cape region. Map 231.

Vouchers: *Brenan M3356; Crosby & Crosby 7574; Magill 4908; Van Rooy 158.*

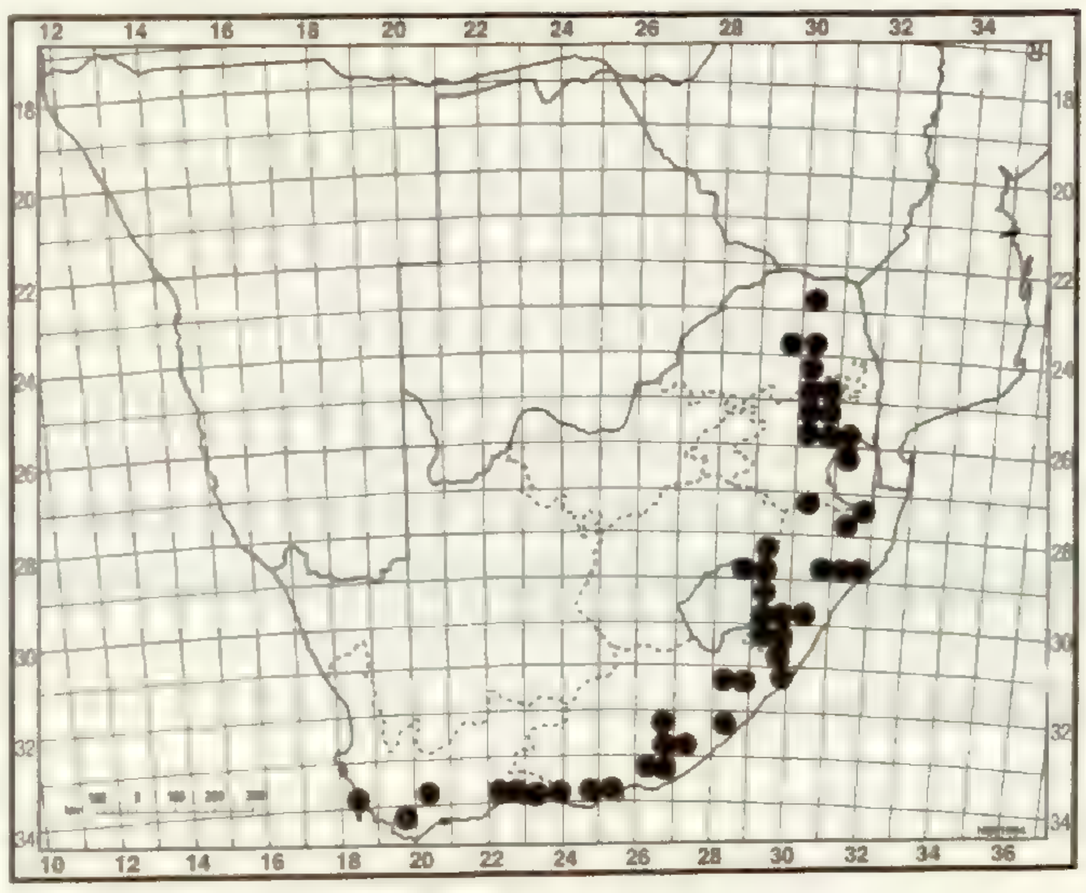
The plants are generally smaller, darker in colour and have shorter leaves than the other species of *Porotrichum* in the *Flora* area. In addition the leaf cells are shorter and broader especially at the apex and the margins are more strongly denticulate. This species could be confused with very small plants of *Porothamnium stipitatum*, but that species has marginal teeth on the leaf blade which are composed of 2–4 cells each.

2. **Porotrichum madagassum** *Kiaer ex Besch.* in Ann. Sci. Nat. Bot. 6, 10: 332 (1880). Type: Madagascar, *Borgen s.n.*, 1875.

Porotrichum penniforme ('*pennaeforme*') C. Müll. in Hedwigia 38: 127 (1899). *Porothamnium penniforme* ('*pennaeforme*') (C. Müll.) Fleisch., Musc. Buitenzorg 3: 926 (1908). Syntypes: South Africa. Cape Prov., Oudebosch, *Breutel s.n.*; Blanco, *Rehmann s.n.*, Oct. 1875; Somerset East, Boschberg, *MacOwan s.n.*, Nov. 1873 (PRE).

Plants medium-sized to large, in loose colonies, green to yellow-green; saxicolous or sometimes corticolous. *Primary stems* long-creeping; secondary stems erect, 60–100 mm long, branching irregular above stipe, ± dendroid; in section round to oval, central strand small, inner cortical cells thin-walled, in 12–14 rows, outer cortical cells thick-walled, red-brown, in 8–10 rows. *Leaves* somewhat crowded, flattened, erect-appressed; stem leaves broadly ovate to elliptical, 1.5–2.5 mm long; acute to short-acuminate; narrowed to insertion; margins plane, serrate above, entire below; branch leaves ovate to elliptical, somewhat smaller. *Costa* single, extending to midleaf or above, smooth, not ending in spine; in section elliptical, of 2 or 3 rows of undifferentiated cells. *Upper laminal cells* rhomboidal to somewhat fusiform, homogeneous, 20–40 µm long, 5–6 µm wide, walls weakly thickened, smooth; basal cells ± oblong, not strongly differentiated, 35–65 µm long, 6–8 µm wide, greenish, walls thickened and pitted, smooth; alar cells not differentiated.

Perigonia gemmate. *Perichaetial leaves* oblong-acuminate, to 3 mm long, leaf cells oblong, thickened and pitted. *Seta* 10–15 mm long, red-brown, smooth. *Capsule* exserted, erect, ovoid, 1.5–2.0 mm long, smooth, red-brown; exothecial cells ± hexagonal, walls thin; cells at mouth rounded; annulus present, differentiated; stomata phaneropore on neck. *Peristome* double, yellow; exostome teeth linear,



MAP 233.—**Porotrichum madagassum**

recurved dry, inflexed wet, papillose-striate, with median zigzag line or perforated along midline, 700–800 µm high; endostome segments linear and perforated above low basal membrane, as long as teeth, papillose; cilia absent. *Operculum* obliquely rostrate, 1 mm long. *Calyptra* cucullate, ± smooth. *Spores* rounded, 18–20 µm, papillose, brownish. Fig. 166: 1–9.

Porotrichum madagassum is frequently found in moist forests of central, eastern and southern Africa, Madagascar and the East African islands. In southern Africa the species is found in the forests of the northern and eastern Transvaal areas, Swaziland, Zululand, KwaZulu-Natal and the eastern, southern and southwestern Cape regions. Map 233.

Vouchers: *Crosby & Crosby 8034; Magill 7002; Oliver 6807; Von Breitenbach 174.*

In addition to being the most commonly collected species of *Porotrichum* in the *Flora* area, *P. madagassum* is recognized by its yellow-green colour, ± flaccid appearance and leaves that appear more delicate than other related

FIG. 166.—**Porotrichum madagassum** (1–9): **1.** habit (wet), × 1; **2.** part of stem in cross section, × 175; **3.** stem leaf, × 35; **4.** branch leaf, × 35; **5.** basal cells of stem leaf (left side), × 175; **6.** upper laminal cells of stem leaf at left margin, × 350; **7.** perichaetial leaf, × 35; **8.** part of capsule mouth with peristome, × 70; **9.** spore, × 700. **P. usagarum** (10–14): **10.** habit (dry), × 1; **11.** branch leaf, × 35; **12.** stem leaf, × 35; **13.** upper laminal cells of stem leaf at left margin, × 350; **14.** stem leaf apex, × 175. **P. elongatum** (15–19): **15.** habit (dry), × 1; **16.** stem leaf, × 35; **17.** branch leaf, × 35; **18.** upper laminal cells of stem leaf showing dorsal spine of costa, × 700; **19.** stem leaf apex, × 175. (1, *Van Rooy 1622*; 2, 4 & 6, *Van Rooy 1426*; 3 & 5, *Von Breitenbach 153*; 7, *Wood 2651*; 8 & 9, *Sim 7282*; 10–14, *Van Rooy 1884*; 15, 16, 18 & 19, *Van der Schijff 4956*; 17, *Sim PRE-CH9906*.)

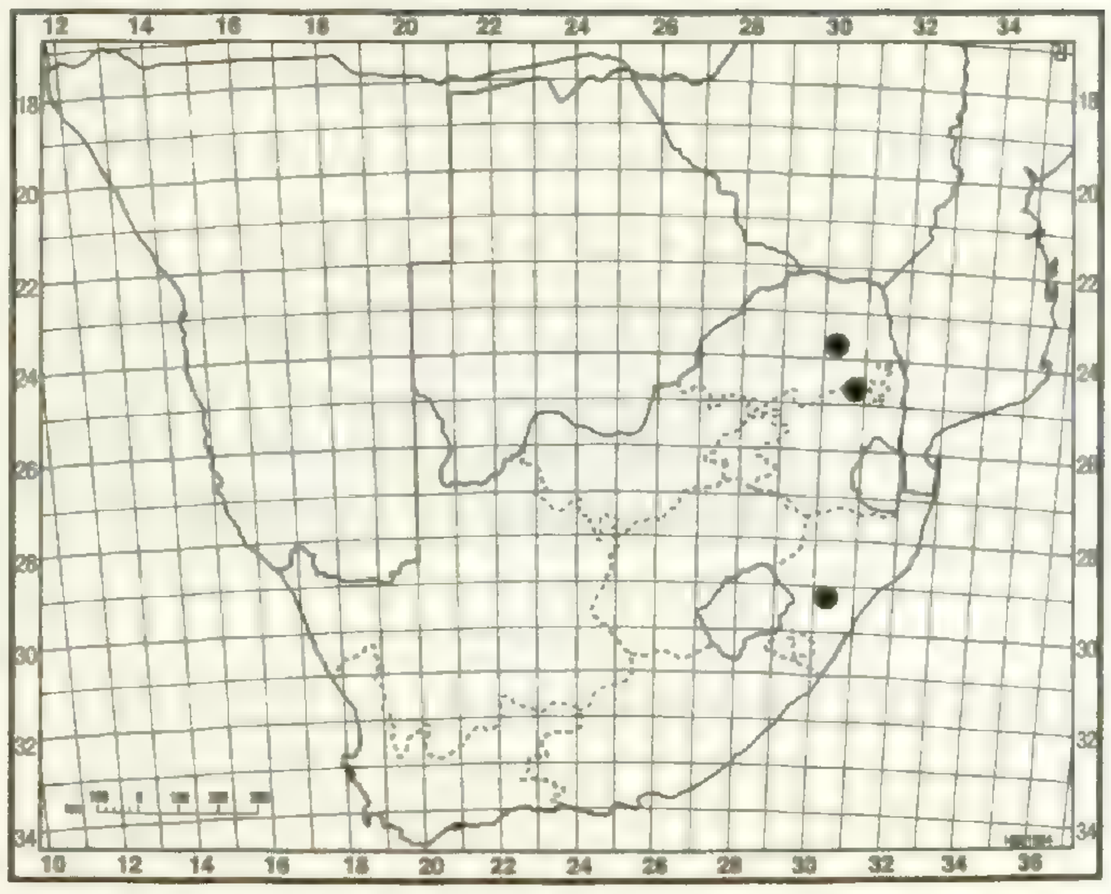
species. The species is quite variable and individual specimens have been confused with each of the other species. It is perhaps most difficult to separate from *P. elongatum* (see note below), but that species has the costa ending in a dorsal spine. Specimens with shorter leaf cells have been confused with *P. usagarum*, but that species is always smaller, darker green and has shorter, broader leaves. The very strong teeth on the leaf margins of *Porothamnium stipitatum* separate it from *P. madagassum* which has only a weakly serrate apex.

3. **Porotrichum elongatum** *(Welw. & Dub.) Gepp* in Hiern, Cat. Afr. Pl. 2,2: 294 (1901); Broth. in Natürl. PflFam., edn 2, 11: 197 (1925); De Sloover in Bull. Jard. Bot. Belg. 53: 101 (1983). Type: Angola, Golungo-Alto region, *Welwitsch s.n.*

Homalia elongata Welw. & Duby in Mém. Soc. Phys. Genève 21: 429 (1871).

Porotrichum comorense Hampe ex C. Müll. in Linnaea 40: 270 (1876); Broth. in Natürl. PflFam., edn 2, 11: 197 (1925). *Porothamnium comorense* (C. Müll.) Sim, Bryo. S. Afr. 402 (1926). Type: Comoros, Irhamia, *Hildebrandt s.n.*, 1834 (BM, PC).

Plants medium-sized, forming loose colonies, green to yellow-green; corticolous. *Primary stems* creeping; secondary stems erect, 30–120 mm long, branching irregular above stipe, pinnate or lower branches irregularly once-pinnate; in section round to oval, central strand small, inner cortical cells thin-walled, hyaline, in 10–12 rows, outer cortical cells thick-walled, yellow, in 4–6 rows. *Leaves* spreading wet, appressed dry; stem leaves broadly ovate to elliptical, 1.0–1.5 mm long; short acuminate; rounded at base; margins plane to erect above, serrulate above; branch leaves similar to stem leaves but smaller and more elliptical, 0.5–1.0 mm long; acute to acuminate; rounded at base; margins plane, serrulate above. *Costa* smooth but ending below apex in a short dorsal spine; in section elliptical. *Upper laminal cells* rhomboidal to fusiform, homogeneous, 20–40 µm long, 5–7 µm wide, walls thin, smooth; basal cells fusiform and longer but not forming distinct groups, greenish, walls ± thickened, smooth; alar cells not forming distinct groups.



MAP 234.—**Porotrichum elongatum**

Perigonia and perichaetia not seen. *Sporophyte* not found in southern Africa but described as: *Seta* erect, to 14 mm long. *Capsule* erect, elliptical, 1.5–1.8 mm long. *Peristome teeth* 700–750 µm, papillose; endostome segments almost as long as teeth, cilia absent. *Operculum* conic-rostrate, 1.0–1.5 mm long. *Calyptra* cucullate, smooth, 2.0–2.5 mm long. *Spores* round, 10–15 µm, finely papillose, light yellow. Fig. 166: 15–19.

Porotrichum elongatum is found in forests of sub-Saharan Africa, Madagascar and the East and West African islands. In the *Flora* area the species is extremely rare and currently known from a few specimens collected in KwaZulu-Natal and the northern and eastern Transvaal regions. Map 234.

Vouchers: *Loocke PRE-CH11205; J. Sim PRE-CH9906; Van der Schijff 4956.*

Only a few South African specimens appear to fit within the concept of this species. The collections are very similar to *P. madagassum* but differ in having the costa end in a short dorsal spine. All of the specimens seen from southern Africa are poor or mixed and may indicate that these specimens represent random introductions and not an established species. The prorate leaf cells described for this species were not found on the South African specimens. It is also possible that these specimens represent an aberrant form of *P. madagassum.*

HOOKERIACEAE

Plants small to large, in tufts or mats, dark green to yellow-green; corticolous, terricolous or saxicolous. *Stems* generally creeping, short; central strand present or absent; paraphyllia absent; pseudoparaphyllia absent. *Leaves* large, frequently appressed and flattened; margins frequently bordered, toothed or entire. *Costa* generally strong, double, extending to above midleaf, sometimes single or short and double. *Laminal cells* large, firm-walled, frequently pitted; alar cells not differentiated.

Perichaetia lateral along stems, generally small. *Seta* mostly short, smooth or rough above, sometimes throughout. *Capsule* small, inclined, dark brown. *Peristome* double, well developed; exostome teeth striate or papillose below, frequently strongly grooved; endostomes generally lacking cilia. *Operculum* rostrate. *Calyptra* cucullate, smooth to rough or hairy. *Spores* small, weakly ornamented.

The family is widespread in the tropics and warm, moist temperate regions. It contains 32 genera; only 8 are presently known from the *Flora* area.

1 Costa ending in lower leaf, short and double or single and bifurcate . . . . . 1. **Calyptrochaeta**

1 Costa extending above midleaf, single or double:

2 Costa double:

3 Leaf cells variably papillose; leaves frequently blunt or rounded at apex . . . . . 2. **Callicostella**

3 Leaf cells smooth; leaves acute:

4 Leaves bordered, margins entire or serrate above; leaf cells subquadrate to hexagonal . . . . . 3. **Cyclodictyon**

4 Leaves not bordered, margins serrate above; leaf cells rhomboidal:

5 Leaves coarsely and bluntly serrate above by inflated cells that are frequently two-pointed; seta smooth; capsule inclined to nodding . . . . . 4. **Hookeriopsis**

5 Leaves sharply serrate above by narrow, single-pointed cells; seta scabrous; capsule ± erect . . . . . 5. **Lepidopilidium**

2 Costa single:

6 Stems simple or weakly branched, homophyllous; leaf margins entire . . . 6. **Distichophyllum**

6 Stems highly branched, heterophyllous; leaf margins serrate:

7 Plants flabellate; amphigastria broadly ovate, abruptly cuspidate . . . . . 7. **Hypopterygium**

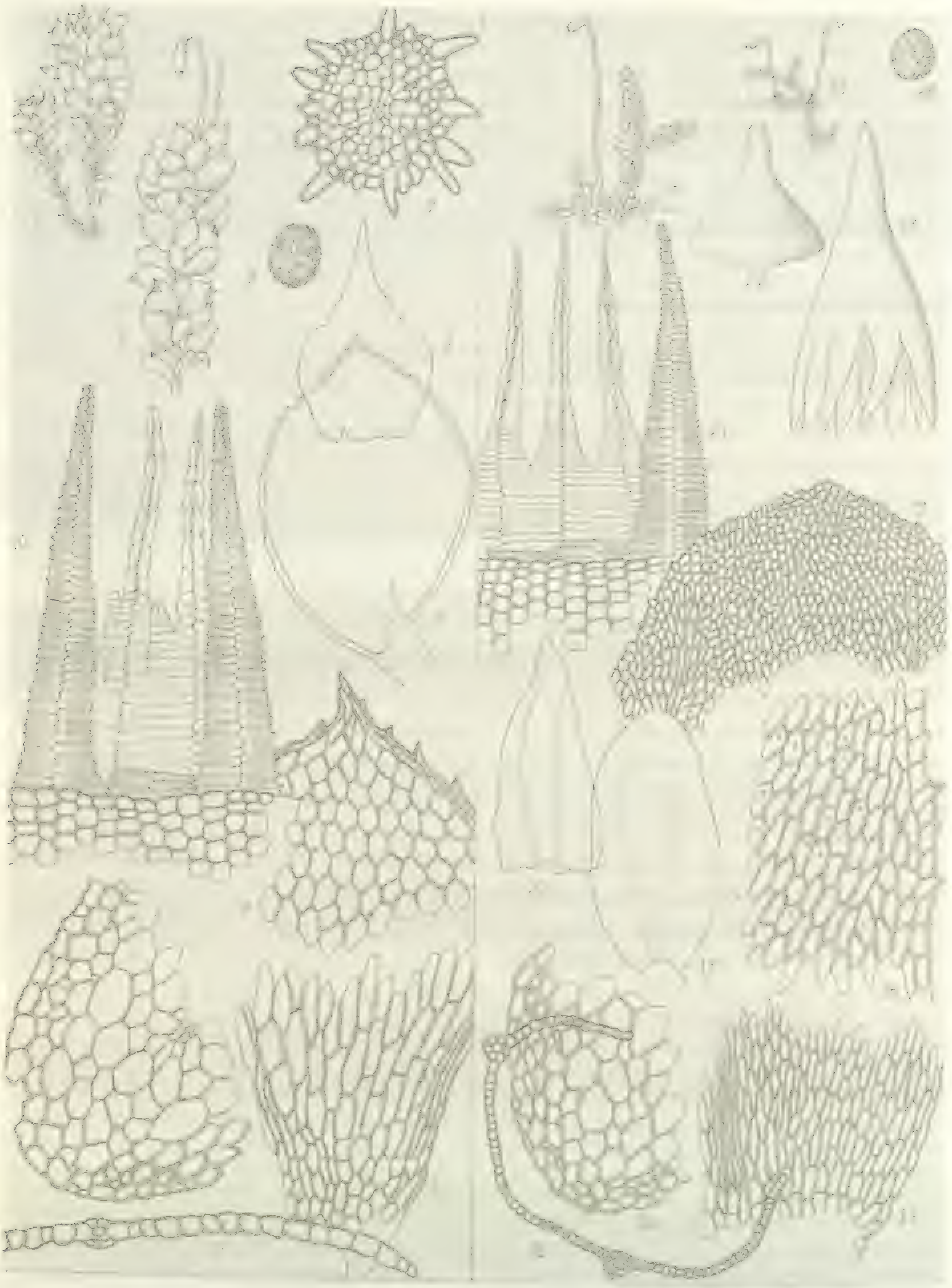
7 Plants pinnate; amphigastria lanceolate . . . . . 8. **Lopidium**

1. CALYPTROCHAETA

Calyptrochaeta *Desv.* in Mém. Soc. Linn. Paris 3: 226 (1825). Type species: *C. cristata* (Hedw.) Desv.

Eriopus Brid., Bryol. univ. 2: 788 (1827); Sim, Bryo. S. Afr. 442 (1926); Broth. in Natürl. PflFam., edn 2, 11: 232 (1925). Type species: *E. cristata* (Hedw.) Brid.

Plants medium-sized, in tufts; saxicolous or terricolous. *Stems* erect, sparsely branched; central strand present. *Leaves* flattened in single plane, larger above; elliptical to broadly spathulate; rounded-apiculate; margins bordered, plane, serrate. *Costa* short and double. *Laminal cells* large, hexagonal, thin-walled, pitted.



Dioicous. *Seta* roughly papillose throughout. *Capsule* inclined. *Peristome* double, complete; cilia present. *Operculum* rostrate. *Calyptra* cucullate. *Spores* small.

This genus includes 15 species found mostly in the southern hemisphere. A single species is known from eastern and southern Africa and Madagascar. Some specimens of *Calyptrochaeta* could be confused with *Plagiomnium* Koponen; however, that genus has leaves with a long, single costa and a truncate apex.

Calyptrochaeta asplenioides *(Brid.) Crosby* in Rev. Bryol. Lichénol. 42: 712 (1976). Type: in Insula Barbonia habitat, *Bory St Vincent s.n.* (BM).

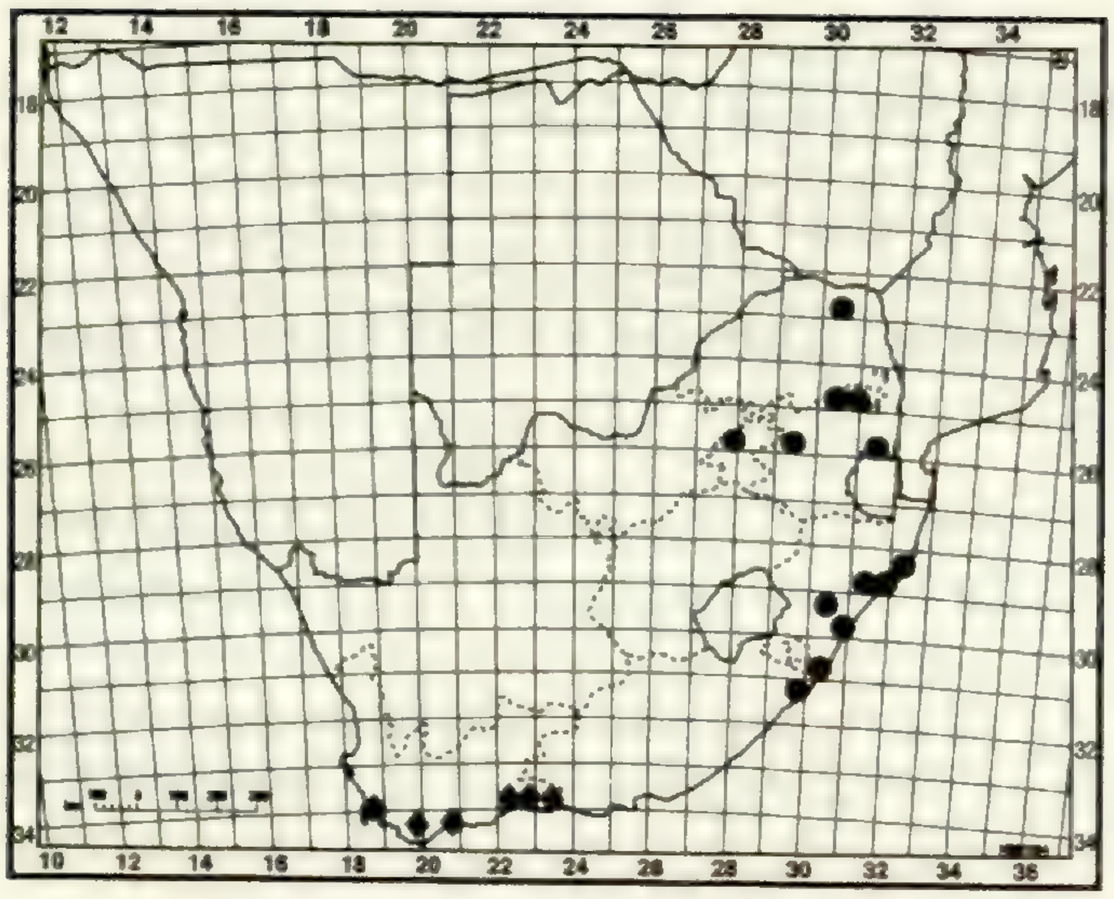
Pterygophyllum asplenioides Brid., Muscol. recent. suppl. 4: 151 (1818). *Eriopus asplenioides* (Brid.) Besch. in Ann. Sci. Nat. Bot. 6, 10: 281 (1880); Broth. in Natürl. PflFam., edn 2, 11: 233 (1925).

Hookeria mniacea C. Müll. in Bot. Zeitung (Berlin) 17: 247 (1859). *Eriopus mniaceus* (C. Müll.) Broth. in Natürl. PflFam. 1,3: 931 (1907); Sim, Bryo. S. Afr. 442 (1926). Type: Prom. bonae spei, Soutkloof, *Breutel s.n.*

Plants medium-sized to large, forming turfs, light green to dark green; saxicolous or terricolous. *Stems* suberect, 10–30 mm long, branching sparse, irregular; in section round, central strand small, inner cortical cells thin-walled, hyaline, in 3 or 4 rows, outer cortical cells somewhat thick-walled, yellow to red, in 3 rows. *Leaves* evenly spaced, larger above, spreading wet, appressed dry, ± flattened into one plane; somewhat asymmetrical, broadly ovate to elliptical or broadly spathulate, largest leaves 3–6 mm long; rounded and apiculate; strongly narrowed to insertion; margins plane, serrate to denticulate above midleaf; bordered by elongated, thickened cells, unistratose. *Costa* short and double or single and bifurcate, ending in lower leaf, smooth; in section elliptical, cells small, thickened. *Upper laminal cells* homogeneous, hexagonal to rhomboidal, 100–112 µm long, 50–56 µm wide, walls thickened, pitted, smooth; basal cells rhomboidal, greenish, walls thickened, pitted, smooth; alar cells not differentiated.

Dioicous. *Perigonia* not seen. *Perichaetia* small, green; perichaetial leaves ovate-acuminate but with some leaves truncate, 1–2 mm long, leaf cells rectangular to rhombic or fusiform. *Seta* to 10 mm long, yellow-brown, roughly papillose throughout. *Capsule* exserted, inclined to nodding, weakly pyriform, 1.8–2.5 mm long, smooth, red brown; urn ovoid; neck differentiated, shorter than urn, curved; exothecial cells rounded to quadrate, walls thickened, collenchymatous, cells at mouth quadrate, neck cells irregular, quadrate to rectangular, stomata not seen. *Peristome* double, yellow; exostome teeth triangular, reflexed dry, inflexed wet, striate below with obvious zigzag line, papillose above, 400 µm high; endostome segments lanceolate above high basal membrane, keeled, as long as teeth, weakly granulate; cilia single, broad, almost as long as segments, weakly granulate. *Operculum* convex-rostrate, 0.5 mm long. *Calyptra* cucullate, rough when young. *Spores* rounded, 12–17 µm, weakly granulate, yellow-brown. Fig. 167: 1–11.

FIG. 167.—**Calyptrochaeta asplenioides** (1–11): **1.** habit (dry), × 1; **2.** habit (wet), × 3; **3.** part of stem in cross section, × 87; **4.** leaf, × 18; **5.** part of leaf in cross section, × 175; **6.** basal leaf cells (right side), × 70; **7.** cells at leaf apex, × 70; **8.** perichaetial leaf, × 18; **9.** seta in cross section, × 87; **10.** part of capsule mouth with peristome, × 175; **11.** spore, × 700. **Callicostella tristis** (12–24): **12.** habit (dry), × 1; **13.** habit (wet), × 3; **14.** part of stem in cross section, × 175; **15.** leaf, × 35; **16.** leaf in cross section, × 175; **17.** basal leaf cells (right side), × 175; **18.** upper laminal cells at right margin, × 350; **19.** leaf apex, × 175; **20.** perichaetial leaf, × 35; **21.** part of capsule mouth with peristome, × 175; **22.** operculum, × 35; **23.** calyptra, × 28; **24.** spore, × 700. (1, 2 & 5, *Crosby 8606*; 3, *Magill 6006*; 4, 6 & 7, *Jacot Guillarmod PRE-CH12571*; 8–11, *Crosby 7389*; 12 & 13, *Van Rooy 166*; 14–16, 18–22 & 24, *Van Rooy 977*; 17, *Wager PRE-CH11624*; 23, *Taylor PRE-CH12635*.)



MAP 235.— ♦ **Calyptrochaeta asplenioides**
● **Callicostella tristis**

Calyptrochaeta asplenioides is known from Tanzania, Madagascar, the East African islands and South Africa. In the *Flora* area it is restricted to indigenous forests of the southern and southwestern Cape regions. The relatively large plants are found on rock or humus near streams or on rock overhangs where water is plentiful. Map 235.

Vouchers: *Crosby & Crosby 8606; Esterhuysen 26687; Magill 6006.*

Within the family the species is recognized by its large bordered leaves, short, mostly double costa, and large hexagonal leaf cells. Sporophytes are rare but when present the papillae on the seta are obvious with a hand lens.

2. CALLICOSTELLA

Callicostella *(C. Müll.) Mitt.* in J. Linn. Soc., Bot. Suppl. 1: 136 (1859), nom. cons.; Sim, Bryo. S. Afr. 444 (1926); Broth. in Natürl. PflFam., edn 2, 11: 238 (1925). Type species: *C. papillata* (Mont.) Mitt.

Schizomitrium B.S.G., Bryol. eur. 5: 59 (1851), nom. rejic. Type species: not designated.

Plants small, in mats; terricolous, corticolous or saxicolous. *Stems* creeping; central strand absent. *Leaves* complanate, broadly oblong to lingulate; truncate; margin serrate, not bordered. *Costa* double, extending to upper leaf. *Alar cells* not differentiated.

Seta elongate, ± smooth. *Capsule* horizontal, dark red. *Peristome* double, incomplete; cilia absent. *Operculum* beaked. *Calyptra* mitriform. *Spores* small, green.

A genus of over 100 species found in tropical and subtropical forests, mostly of the southern hemisphere.

Callicostella tristis *(C. Müll.) Broth.* in Natürl. PflFam. 1,3: 938 (1907); Sim, Bryo. S. Afr. 444 (1926); Broth. in Natürl. PflFam., edn 2, 11: 239 (1925). Type: South Africa, Natal, Inanda, *Rehmann s.n.* (BM, NH, in PRE *Rehmann* specimen numbered as *624*).

Hookeria tristis C. Müll., Hedwigia 38: 130 (1899). *Schizomitrium triste* (C. Müll.) Ochyra in Ochyra & Pocs, Acta Bot. Acad. Sci. Hung. 28: 382 (1982).

Callicostella applanata Broth. & Bryhn in Bryhn, Forh. Vidensk.-Selsk. Kristiania 4: 19 (1911); Sim in Bryo. S. Afr. 445 (1926); Broth. in Natürl. PflFam., edn 2, 11: 239 (1925). *Schizomitrium applanatum* (Broth. & Bryhn) Ochyra in Ochyra & Pocs, Acta Bot. Acad. Sci. Hung. 28: 381 (1982). Type: South Africa, Zululand, Eshowe, *H. Bryhn*, Nov. 1908 (H-BR).

Plants small, forming mats, grey-green to yellow-green; terricolous, humicolous, saxicolous or corticolous. *Stems* creeping, 15–30 mm long, branches irregular, scattered; in section round or oval, central strand absent, inner cortical cells thin-walled, in 2 or 3 rows, outer cortical cells smaller, ± thick-walled, red-brown. *Leaves* evenly spaced, spreading wet, ± crisped and curved downward dry; broadly ovate to oblong, 1–2 mm long; apex variable, truncate or rounded to obtuse or almost acute;

rounded and narrowed to insertion; margins plane, serrate, cells not differentiated. *Costa* double, ending below apex, with a single dorsal tooth at each tip, smooth or ridged dorsally; ventral surface smooth, cells elongate; dorsal surface toothed above, bulging or ridged, cells elongate; in section bulging dorsally. *Upper laminal cells* irregularly shaped, homogeneous, 12–20 µm long, 5–8 µm wide, walls weakly thickened, papillose above dorsally but some papillae on ventral surface; papillae single, low, centred over lumen; basal cells almost rectangular, forming distinct group, 25–37 µm long, 8–15 µm wide, hyaline, smooth; alar cells not forming distinct groups.

Dioicous? *Perichaetia* small, green; perichaetial leaves ovate to oblong, 1 mm long; acute to acuminate; leaf cells ± rectangular. *Seta* 10–15 mm long, red-yellow, ± smooth. *Capsule* exserted, horizontal, ovoid, 1 mm long, smooth, dark red; urn ovoid; neck tapering, shorter than urn; exothecial cells short rectangular, walls collenchymatous, cells at mouth transversely rectangular, neck cells rectangular; stomata on neck cryptopore, formed of 4 cells, some not functional. *Peristome* double, red; exostome teeth triangular, inflexed at tips dry, erect appressed wet, striate and deeply furrowed below, papillose above, 200 µm high; endostome segments lanceolate and keeled above high basal membrane, as long as teeth, weakly granulate; cilia absent. *Operculum* rostrate, when young body yellow, beak dark red, 0.5 mm long. *Calyptra* large, mitrate, 2 mm long, rough above. *Spores* rounded, 10–13 µm, weakly papillose, green. Fig. 167: 12–24.

Reported from central, western and southern Africa, *Callicostella tristis* is found on rocks, humus or soil in forests of the northern, central and eastern Transvaal areas, Swaziland, Zululand, KwaZulu-Natal, and the eastern Cape region. Eleven other species have been recorded from eastern Africa, several related to *C. tristis*. Map 235.

Vouchers: *Bernard 9076-A; Edwards 13; Magill 5337; Van Rooy 166, 1886.*

The leaves of this species are complanate and become somewhat crisped and downturned when dry. The unbordered leaves with strong, double costae and papillose upper laminal cells place the plants in the Hookeriaceae. The papillae are variable and leaf cells must frequently be cleared to detect them.

Callicostella tristis is similar to the widespread tropical American species *C. pallida* (Hornsch.) Ångstr., but differs mostly in a weaker ornamentation of its seta and variable leaf cell papillae. The characters used to differentiate *C. applanata* are quite variable even on the type specimen; this species is therefore placed in the synonymy of *C. tristis*.

3. CYCLODICTYON

Cyclodictyon *Mitt.* in J. Linn. Soc., Bot. 7: 163 (1864); Sim, Bryo. S. Afr. 442 (1926); Broth. in Natürl. PflFam., edn 2, 11: 236 (1925). Type species: *C. pteridioides* P. Beauv.

Plants small to medium-sized, in small mats, green to yellow green; humicolous or saxicolous. *Stems* creeping; central strand absent. *Leaves* flattened, broadly ovate to elliptical; margins bordered, entire to serrate. *Laminal cells* large, ± hexagonal, thin-walled; basal cells rectangular; alar cells not differentiated.

Seta elongate, smooth. *Capsule* horizontal, blackish. *Peristome* double, complete; cilia single, rudimentary. *Operculum* rostrate. *Calyptra* mitrate, rough. *Spores* small, green.

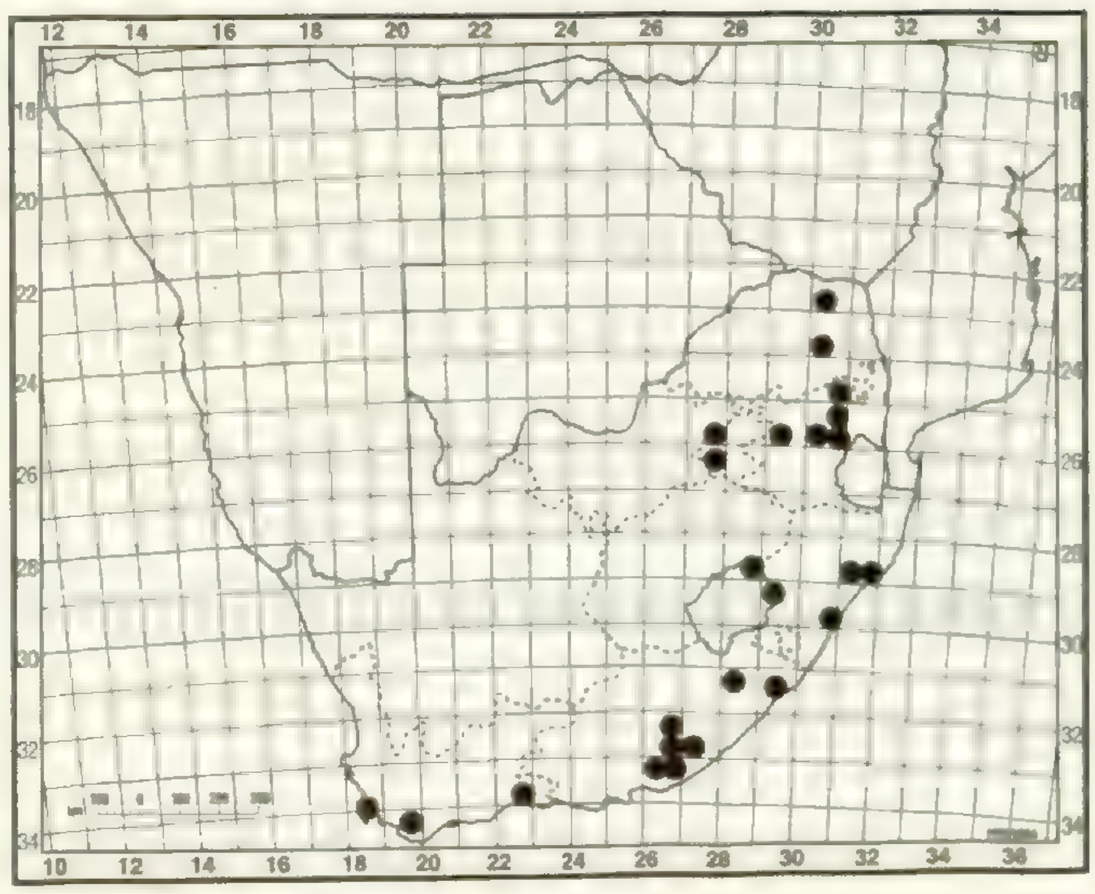
A tropical to subtropical genus of about 100 species, most of which are found in the Americas. About 20 taxa have been reported or described from Africa, and one or two species are known from Europe, Australia and Pacific islands.

Cyclodictyon vallis-gratiae *(Hampe) O. Kuntze*, Revis. gen. pl. 2: 835 (1891); Sim, Bryo. S. Afr. 443 (1926); Broth. in Natürl. PflFam., edn 2, 11: 237 (1925). Type: Prom. bon. spei, Genadendal, *s.n.* & *s.l.* (BM herb. Hampe).

Hookeria vallis-gratiae Hampe ex C. Müll. in Bot. Zeitung (Berlin) 16: 169 (1858).

Hookeria breuteliana Hampe in C. Müll. in Bot. Zeitung (Berlin) 17: 247 (1859). *Cyclodictyon breutelianum* (Hampe) O. Kuntze, Revis. gen. pl. 2: 835 (1891); Broth. in Natürl. PflFam., edn 2, 11: 236 (1925). *Cyclodictyon vallis-gratiae* fo. *breuteliana* Demar. & P. Varde in Bull. Jard. Bot. État 21: 45 (1951). Type: Prom. bon. spei, Oude Bosch inter *H. vallis-gratiae*, *Breutel s.n.* (BM).

Hookeria breutelii Hampe ex Kindb., Enum. Bryin. exot. 16 (1888), nom. illeg. incl. spec. prior.



MAP 236.—**Cyclodictyon vallis-gratiae**

Plants small to medium-sized, forming mats, green; humicolous or saxicolous. *Stems* creeping, 10–30 mm long, branching sparse, irregular; in section oval, central strand absent, inner cortical cells large, thin-walled, outer cortical cells larger, thin-walled. *Leaves* somewhat distant, spreading wet, spreading and weakly crisped dry; asymmetrical, oblong to lingulate, 1.2–2.5 mm long; apex rounded and apiculate; narrowed to insertion; margins plane, serrate above, entire below, weakly bordered by elongated cells, unistratose. *Costa* double, ending below apex, smooth but each ending in a dorsal tooth; in section bulging dorsally, consisting of a small group of weakly thickened cells. *Upper laminal cells* quadrate to hexagonal, homogeneous, 25–37 µm long, walls thin, smooth on both surfaces; basal cells forming distinct group, rectangular to rhomboidal, 50–75 µm long, 25 µm wide, greenish, walls thin, smooth; alar cells not differentiated.

Autoicous. *Perigonia* on stem, gemmate; perigonial leaves lanceolate. *Perichaetia* along stem, small, green; perichaetial leaves ovate-acuminate, 1–1.5 mm long, leaf cells large, thin-walled. *Seta* 14–18 mm long, red-brown, smooth. *Capsule* exserted, horizontal, ellipsoid, 1–2 mm long, smooth, red-brown, urn ellipsoidal; neck tapering, shorter than urn; exothecial cells rectangular, walls firm, cells at mouth smaller, quadrate to rectangular, neck cells rectangular; stomata phaneropore, on neck, consisting of 3–6 cells, some not functional. *Peristome* double, red-yellow; exostome teeth lanceolate, inflexed at tip dry, incurved appressed wet, striate below with a deep but broad median furrow, coarsely papillose by a few scattered papillae above, 450 µm high; endostome segments lanceolate, keeled above basal membrane, as long as teeth, papillose; cilia single, rudimentary, granulate. *Operculum* rostrate, 1.0–1.2 mm long. *Calyptra* mitrate, 1.5–1.8 mm long, rough. *Spores* rounded, 8–12 µm, granulate, green. Fig. 168: 1–13.

This species is found in moist forests of eastern, western and southern Africa and the East and West African islands. The plants are rather

FIG. 168.—**Cyclodictyon vallis-gratiae** (1–13): **1.** habit (dry), × 1; **2.** distal part of stem (wet), × 5; **3.** part of stem in cross section, × 175; **4.** leaf, × 32; **5.** part of leaf in cross section, × 175; **6.** leaf base (left side), × 87; **7.** leaf apex, × 87; **8.** perichaetial leaf, × 35; **9.** distal part of sporophyte, × 5; **10.** part of capsule mouth with peristome (papillae partly shown), × 122; **11.** operculum, × 25; **12.** calyptra, × 25; **13.** spore, × 700. **Hookeriopsis pappeana** (14–25): **14.** habit (dry), × 1; **15.** distal part of stem with sporophyte (wet), × 3; **16.** part of stem in cross section, × 175; **17.** leaf, × 35; **18.** part of leaf in cross section, × 175; **19.** basal leaf cells (right side), × 175; **20.** cells at leaf apex, × 175; **21.** perichaetial leaf, × 35; **22.** part of capsule mouth with peristome, × 122; **23.** operculum, × 25; **24.** calyptra, × 25; **25.** spore, × 700. (1, 2, 4, 5 & 9, *Van Rooy 1194*; 3, 6 & 7, *Mogg 12558*; 8 & 10–13, *Wager 15*; 14, *Van Rooy 1845*; 15 & 21–25, *Van Rooy 873*; 16–18 & 20, *Crosby 7899*; 19, *Sim 7232*.)

rare in the *Flora* area but have been found on decaying wood or on rock in kloof forests of the northern, eastern, central and southern Transvaal areas, Zululand, KwaZulu-Natal and the eastern, southern and southwestern Cape regions. Map 236.

Vouchers: *Arnell, 1973; Crosby & Crosby 7558, 7521; Wager 15.*

There are 11 species of *Cyclodictyon* in eastern Africa, most of which are closely related to *C. vallis-gratiae*. The southern African species is known by its broad, bordered leaves that have very large hexagonal leaf cells and a double costa reaching well above midleaf.

Sim's (1926) reference to *C. laete-virens* Mitt. in southern Africa was in error. The two specimens cited by Sim were both *Hookeriopsis pappeana*; one of them was mixed with *C. vallis-gratiae*.

4. HOOKERIOPSIS

Hookeriopsis *(Besch.) Jaeg.* in Ber. Thätigk. St. Gallischen Naturwiss. Ges. 1875–1876: 358 (1877); Sim, Bryo. S. Afr. 444 (1926); Broth. in Natürl. PflFam., edn 2, 11: 240 (1925); Gangulee. Moss. E. India 7: 1512 (1977). Type species: not designated.

Plants medium-sized to large, forming loose mats, dark green to yellow-green; saxicolous, corticolous or terricolous. *Stems* creeping; central strand absent. *Leaves* complanate, somewhat asymmetrical, elliptical; short acuminate to acute; margins plane, dentate above by enlarged marginal cells. *Costa* double, extending to near midleaf or just above. *Laminal cells* rhomboidal to elongate-rhomboidal, weakly thickened and pitted; alar cells not differentiated.

Autoicous. *Seta* elongate, smooth or rough above. *Capsule* inclined to horizontal or nodding. *Peristome* double, incomplete, cilia absent. *Operculum* rostrate. *Calyptra* mitrate. *Spores* small.

A genus of over 120 species found in Central and South America, Africa, India and Asia. Ten species have been reported from Africa. The single species reported from the *Flora* area is also found in east Africa.

Hookeriopsis pappeana *(Hampe) Jaeg.* in Ber. Thätigk. St. Gallischen Naturwiss. Ges. 1875–1876: 360 (1877); Sim, Bryo. S. Afr. 444 (1926); Broth. in Natürl. PflFam., edn 2, 11: 243 (1925). Type: South Africa, Cape Prov., Zwellendam, *Pappe s.n.* (BM, iso.).

Hookeria pappeana Hampe, Icon. Musc. 2 (1844).

Plants medium-sized, forming loose mats, dark green to yellow green, occasionally tinged with dark red; terricolous, saxicolous or corticolous. *Stems* creeping, 10–30 mm long, branching sparse, irregular; in section round, central strand absent, inner cortical cells thin-walled, hyaline, in 3 or 4 rows, outer cortical cells smaller, weakly thick-walled, yellow-brown, in 2 or 3 rows, epidermis fragile, of enlarged thin-walled cells. *Leaves* crowded, widespreading wet, spreading and crisped dry, ± falcate and somewhat asymmetrical; oblong to elliptical, 1.5–2.5 mm long; apex shortly acuminate; rounded to base; margins plane, entire below, dentate by enlarged, frequently double-pointed marginal cells; not bordered. *Costa* double, extending to midleaf, smooth; in section a small group of smaller, weakly thickened cells, bulging dorsally. *Upper laminal cells* rhomboidal to subfusiform, homogeneous, (37)50–75 µm long, 12–18 µm wide, walls thickened, weakly pitted, smooth; basal cells not strongly differentiated, oblong to rhomboidal, 50–75 µm long, 12–18 µm wide, walls thickened, weakly pitted, smooth; alar cells not differentiated.

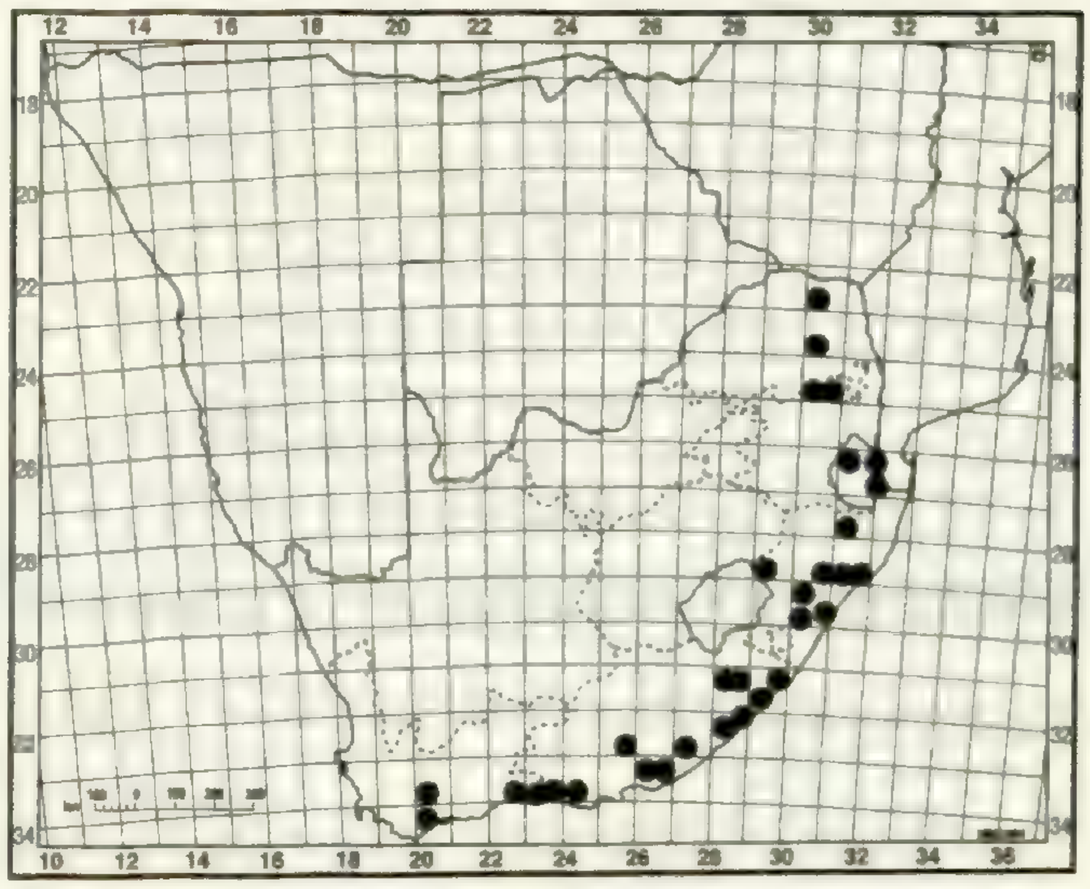
Autoicous. *Perigonia* on stem, gemmate; perigonial leaves ovate-cuspidate, to 1 mm long. *Perichaetia* along stem, not strongly differentiated; perichaetial leaves lanceolate to

ovate-acuminate, to 2 mm long, leaf cells linear, somewhat sigmoid. *Seta* 10–15 mm long, dark red-brown, smooth. *Capsule* exserted, inclined to drooping, short-cylindrical, 1.0–1.5 mm long, smooth, dark red-brown; urn cylindrical; neck shorter than urn; exothecial cells shortly rectangular, walls weakly collenchymatous, cells at mouth quadrate to transversely rectangular, neck cells quadrate; stomata on neck, phaneropore. *Peristome* double, yellow-brown; exostome teeth lanceolate, erect with inflexed tips dry, erect appressed wet, striate below with deep furrow, papillose above, 500 µm high; endostome segments lanceolate and keeled above short basal membrane, as long as teeth, granulate, cilia absent. *Operculum* rostrate, 0.5 mm long. *Calyptra* mitrate, with a few hairs, especially when young, to 2 mm long. *Spores* rounded, 12–14 µm, weakly granulate, greenish. Fig. 168: 14–25.

Hookeriopsis pappeana is known from Tanzania, Uganda, Kenya, Zaïre, Zimbabwe and South Africa and has also been reported from China. In the *Flora* area the species has been collected on soil, rocks and bark at the base of trees, in forests of the northern and eastern Transvaal areas, Zululand, KwaZulu-Natal and the eastern, central, southern and southwestern Cape regions. Map 237.

Vouchers: *Crosby & Crosby 8063; Magill 5148, 6203; Smook 1358; Van Rooy 2234.*

Hookeriopsis pappeana is identified by its



MAP 237.—**Hookeriopsis pappeana**

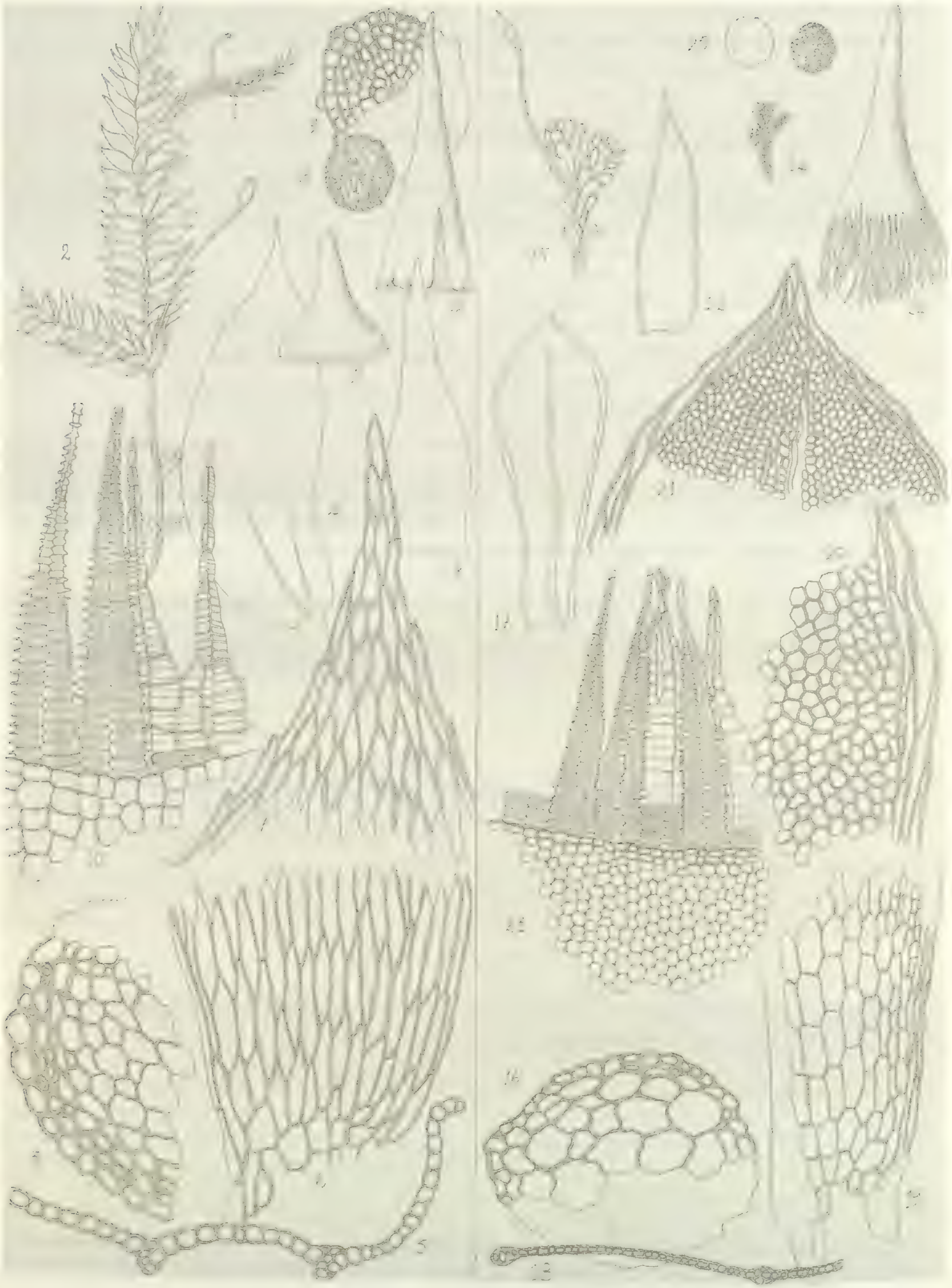
unbordered leaves, double costa and dentation of the upper leaf margins formed by enlarged cells. The species closely resembles *Lepidopilidium hanningtonii*; the two can be separated only under the microscope. The most pronounced vegetative difference is seen in the leaf margins of the two species. The upper leaf margin of *H. pappeana* is dentate by enlarged marginal cells that project out from the leaf margin. These cells are frequently large enough to be visible under a dissecting scope, although this is not always so. In addition the blunt tips of these cells generally have two papilla-like points. In contrast, *L. hanningtonii* is serrate by narrow, sharp-pointed cells. See p. 612 for further differences.

5. LEPIDOPILIDIUM

Lepidopilidium *(C. Müll.) Broth.* in Hedwigia 39: 273 (1900); Broth. in Natürl. PflFam., edn 2, 11: 243 (1925). Type species: not designated.

Plants medium-sized, forming loose mats, green; corticolous. *Stems* creeping; central strand absent. *Leaves* flattened, lateral leaves widespreading, weakly falcate; oblong-acuminate; margins serrate, unbordered. *Costa* double, ending near midleaf. *Laminal cells* rhomboidal, thin-walled, smooth, extending to base of leaf; alar cells not differentiated. *Gemmae* produced in tufts along stem, cylindrical.

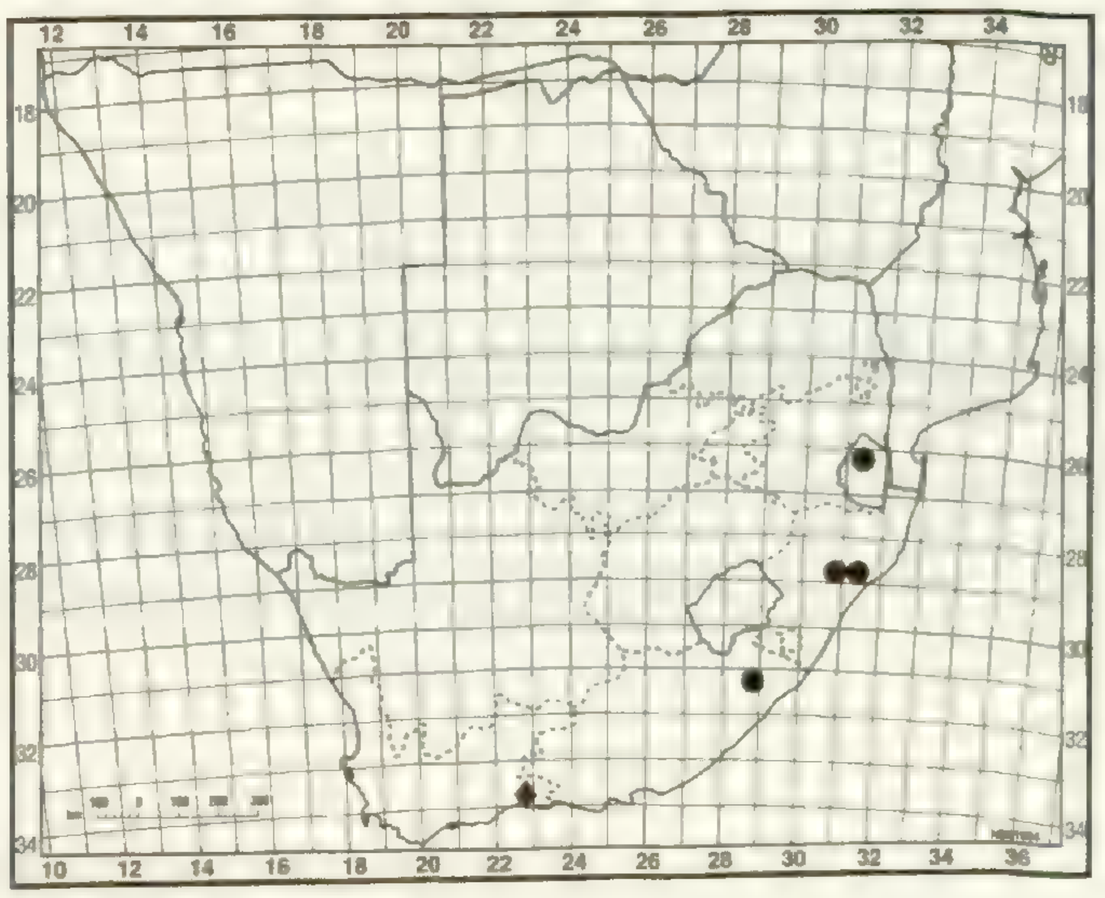
Seta short, papillose. *Capsule* erect. *Peristome* double, incomplete; cilia absent. *Operculum* rostrate. *Calyptra* mitrate. *Spores* large for the family.



The 29 species of *Lepidopilidium* are found in tropical America (14), Africa (5), the East African islands (9) and Asia (1). The genus is related to *Hookeriopsis*, but is distinct in its scabrous seta and erect capsule.

Lepidopilidium hanningtonii *(Mitt.) Broth.* in Natürl. PflFam. 1,3: 944 (1907); Broth. in Natürl. PflFam., edn 2, 11: 244 (1925). Type: Tanzania, Usagara Mts, *Hannington s.n.*, Oct. 1883 (BM, holo.).

Lepidopilum hanningtonii Mitt. in J. Linn. Soc., Bot. 22: 309 (1886).



MAP 238.— ● **Lepidopilidium hanningtonii**
♦ **Distichophyllum mniifolium** var. **taylorii**

Plants medium-sized to large, forming mats, dark green to yellow-green or sometimes tinted red-brown; corticolous. *Stems* creeping, 20–40 mm long, branching irregular; in section round, central strand absent, inner cortical cells thin-walled, hyaline, in 4 rows, outer cortical cells smaller, thick-walled, yellow, in 3 rows, epidermis of enlarged thin-walled cells fragile. *Leaves* somewhat distant but evenly spaced, wide-spreading wet, spreading and narrowed dry, somewhat falcate; oblong to elliptical, 2.0–3.2 mm long; acuminate; narrowed to insertion; margins plane, serrate, not bordered. *Costa* short and double or double and extending to midleaf, smooth; in section a small group of cells bulging dorsally. *Upper laminal cells* rhomboidal, homogeneous, 66–112 µm long, 15–22 µm wide, walls thin to weakly thickened, smooth; basal cells quadrate to short rectangular at attachment, 15–20 µm long, hyaline, walls thin, smooth; alar cells not differentiated. *Gemmae* on stem, in small tufts, cylindrical, to 250 µm, green, smooth.

Autoicous. *Perichaetia* not obvious; perichaetial leaves lanceolate-acuminate, 1.5–2.2 mm long, leaf cells fusiform. *Seta* 2–6 mm long, brown, papillose. *Capsule* exserted, ± erect, ellipsoid, 1 mm long, smooth, yellow-green, mouth red; urn ellipsoidal; neck shorter than urn; exothecial cells quadrate to rectangular, walls weakly collenchymatous, cells at mouth quadrate to transversely rectangular, neck cells quadrate; stomata on neck, phanerogamous. *Peristome* double, red-brown; exostome teeth lanceolate, inflexed dry, erect appressed wet, striate with broad median furrow below, essentially smooth above, 500 µm high; endostome segments lanceolate and keeled above low basal membrane, as long as teeth, granulate; cilia absent. *Operculum* rostrate, 0.5 mm long. *Calyptra* mitrate, to 2 mm long, smooth. *Spores* rounded, 22–25 µm, granulate, light brown. Fig. 169: 1–13.

FIG. 169.—**Lepidopilidium hanningtonii** (1–13): **1.** habit (dry), × 1; **2.** habit (wet), × 5; **3.** part of stem in cross section, × 175; **4.** leaf, × 32; **5.** part of leaf in cross section, × 175; **6.** basal leaf cells (right side), × 175; **7.** cells at leaf apex, × 175; **8.** perichaetial leaf, × 35; **9.** seta in cross section (cells partly shown), × 175; **10.** part of capsule mouth showing cells and peristome, × 175; **11.** operculum, × 25; **12.** calyptra, × 25; **13.** spore, × 700. **Distichophyllum mniifolium** var. **mniifolium** (14–25): **14.** habit (dry), × 1; **15.** habit (wet), × 5; **16.** stem in cross section (cells partly shown), × 175; **17.** leaf, × 35; **18.** part of leaf in cross section, × 175; **19.** basal leaf cells (right side), × 175; **20.** upper laminal cells at right margin, × 350; **21.** leaf apex, × 175; **22.** perichaetial leaf, × 35; **23.** part of capsule mouth showing cells and peristome, × 175; **24.** calyptra, × 58; **25.** spores, × 700. (1 & 2, *Van Rooy 2223*; 3, 8, 9 & 11–13, *Magill 5145*; 4, *Crosby 7786*; 5–7 & 10, *Kemp 1499*; 14–19, 21 & 23, *Duthie PRE-CH8220*; 20, *Russell 2534*; 22 & 24, *Jacot Guillarmod PRE-CH12569*.)

Endemic to Africa, *L. hanningtonii* is found in forests of eastern and southern Africa. In southern Africa the species is found on stems or trunks of trees and shrubs in natural forests in Swaziland, Zululand, KwaZulu-Natal and the eastern Cape region. Map 238.

Vouchers: *Crosby & Crosby 7662; Magill 5109; Van Rooy 2223.*

Lepidopilidium hanningtonii is recognized by its elongate and gently curved leaves, unbordered, serrate leaf margins and double costa that ends below midleaf. The shorter papillose seta and erect capsule separate fertile specimens from *Hookeriopsis pappeana*. Sterile specimens are generally more difficult to separate. The leaves of *L. hanningtonii* are more sharply serrate and as a rule longer and narrower. They are also more curved (weakly falcate), especially when dry. As the leaves dry the cells collapse inward, narrowing the width of the leaf. This also gives the leaves a less crowded appearance on the stem. Each of these conditions also occurs in *H. pappeana*, but rarely to the same degree. Stems of *H. pappeana* appear fuller and leaves not as narrow, when the two species are compared side by side (see p. 609).

6. **DISTICHOPHYLLUM**

Distichophyllum *Doz. & Molk.*, Musc. frond. ined. archip. ind. 4: 99 (1846). Type species: not designated.

Plants medium-sized, green; corticolous. *Stems* erect to suberect; central strand absent. *Leaves* inserted around stem, bordered; lingulate to spathulate; apiculate; margins plane, entire to serrulate. *Costa* single, ending below apex. *Laminal cells* large, thickened, smooth; border cells elongate, incrassate; basal cells large, rectangular; alar cells not differentiated.

Seta lateral. *Capsule* inclined. *Peristome* double, incomplete; cilia absent. *Operculum* rostrate. *Calyptra* mitrate. *Spores* small.

Most of the 118 species of *Distichophyllum* are found around the southern Pacific basin or India; only three species are known from Africa. Many of the other species have complanate, dimorphous leaves and a much shorter costa than the African species.

Distichophyllum mniifolium *(Hornsch.) Sim*, Bryo. S. Afr. 441 (1926). Type: South Africa, Cape, nr. Koratra, *Drège s.n.*, 5 Oct. 1831 (BM, iso.).

Hookeria mniifolia Hornsch. in Linnaea 15: 141 (1841). *Mniadelphus hornschuchii* C. Müll., Syn. musc. frond. 2: 22 (1850), nom. illeg. incl. spec. prior. *Leskeodon mniifolius* (Hornsch.) Biz. in Biz. & Pocs in Acta Acad. Paedagog. Agriensis, n.s. 12: 436 (1974).

Mniadelphus hornschuchii C. Müll. in Hedwigia 38: 130 (1899). Type: South Africa, Cape, Genadendal, *Breutel s.n.* (BM, iso.).

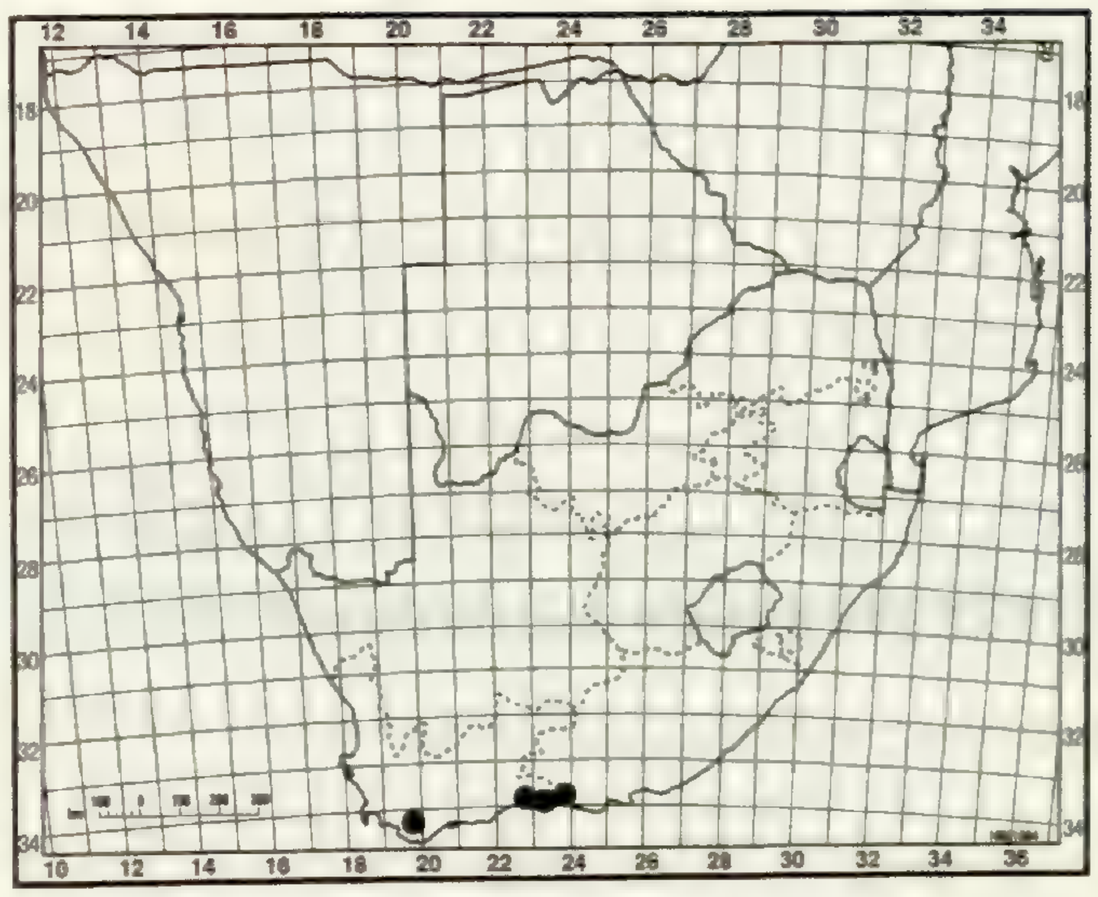
Plants medium-sized, forming turfs, green to yellow-green; corticolous. *Stems* ± erect, 5–12 mm long, branching sparse, irregular; in section round, central strand absent, inner cortical cells large, thin-walled, 2 or 3 cells across, outer cortical cells smaller, thin-walled, red-brown. *Leaves* evenly spaced, larger above, spreading wet, appressed dry, somewhat crisped; lingulate to spathulate, 1.2–2.2 mm long; apiculate; not narrowed at base; margins plane, ± entire or weakly serrulate at apex; bordered by elongated cells. *Costa* single, ending below apex, smooth; ventral and dorsal surfaces smooth, cells elongate; in section bulging dorsally, of 6–8 smaller, incrassate cells. *Upper laminal cells* rounded-quadrate to hexagonal, ± heterogeneous, (6–)8–12(–15) µm long, walls thickened, smooth; border cells thickened and

pitted; basal cells strongly differentiated and forming distinct group, rectangular to oblong-hexagonal, (12–)20–55 µm long, 12–18 µm wide, hyaline, walls smooth; alar cells not differentiated.

Autoicous. *Perichaetia* not obvious; perichaetial leaves oblong-acuminate, 0.5–0.8 mm long, leaf cells ± oblong. *Seta* 5–6 mm long, reddish, smooth. *Capsule* exserted, inclined, short-ellipsoidal, 1.0–1.5 mm long, smooth, brown; neck shorter than urn; exothecial cells rounded to hexagonal, walls collenchymatous, cells at mouth transversely rectangular; neck cells rectangular; stomata on neck, phanerogamous, guard cells 2. *Peristome* double, yellowish; exostome teeth lanceolate, reflexed with inflexed tip dry, erect appressed wet, striate with deep median furrow below, papillose above, 200 µm high; endostome segments lanceolate and keeled above basal membrane, as long as teeth, papillose; cilia absent. *Operculum* rostrate. *Calyptra* mitrate, 1 mm long, fringed below with unicellular hairs. *Spores* rounded, 7–10 µm, smooth to granulate, brownish.

On a single sheet in the Natural History Museum (BM) there are four specimens filed under *Mniadelphus hornschuchii*. The top and bottom specimens from Genadendal are probably isotypes of *M. hornschuchii* C. Müll. [hom. illeg.; Hedwigia 38: 130 (1899)]. The two specimens in the centre are probably isotypes of *Hookeria mniifolia* Hornsch. [Linnaea 15: 141 (1841)]. These latter specimens were incorrectly transferred to *M. hornschuchii* [nom. illeg.; Syn. musc. frond 2: 22 (1850)] by Müller.

Hookeria mniifolia was transferred to *Distichophyllum* by Sim (1926) and later to *Leskeodon* Broth. by Bizot & Pocs (1974). The southern African specimens have hookeriaceous peristomes like *Distichophyllum*, not the daltoniaceous peristome of *Leskeodon*, and therefore Sim's placement is retained.



MAP 239.—**Distichophyllum mniifolium** var. **mniifolium**

Endemic to Africa, *D. mniifolium* is rarely collected on wood in forests of the southern and southwestern Cape regions. It has also been reported from Tanzania by Bizot & Pocs (1974). Two varieties are recognized:

Leaf cells small, irregular, 6–10 µm . . . . . var. *mniifolium*
Leaf cells larger, uniform, 10–16 µm . . . . . var. *taylorii*

Distichophyllum mniifolium *(Hornsch.) Sim* var. **mniifolium**.

See species description and key. Fig. 169: 14–25.

Found on wood in forests of the southern and southwestern Cape regions, and reported from Tanzania. Map 239.

Vouchers: *Duthie (PRE-CH8220); Jacot Guillarmod PRE-CH12569; Russell 2534.*

The suberect plants, large leaf cells, single costa and strong leaf borders should place specimens of var. *mniifolium*. The strongly differentiated basal leaf cells are reminiscent of the cancellinae of Calymperaceae. The small number of specimens examined seems to indicate that the variety is quite variable.

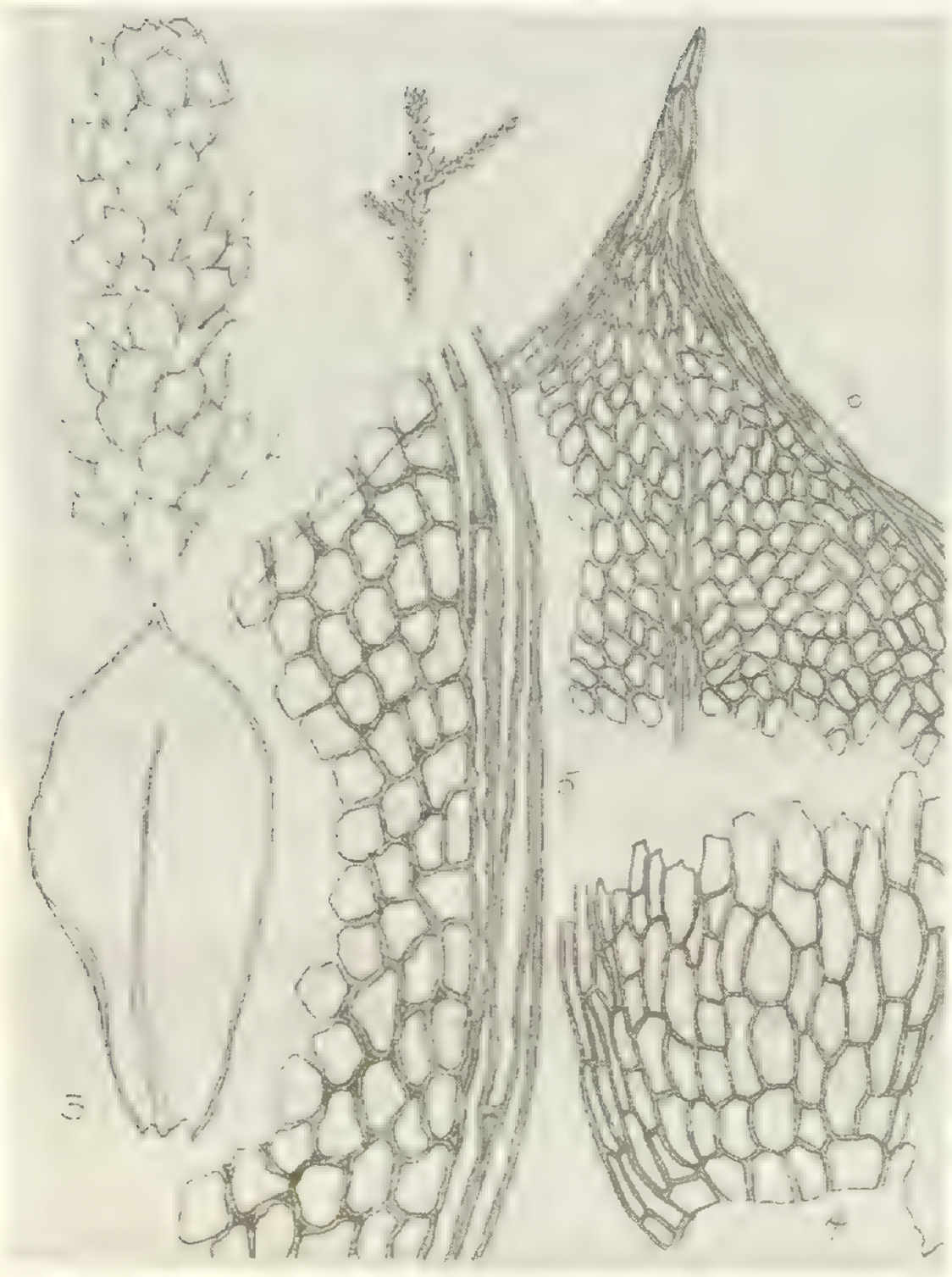


FIG. 170.—**Distichophyllum mniifolium** var. **taylorii**: **1.** habit (dry), × 1; **2.** habit (wet), × 5; **3.** leaf, × 32; **4.** basal leaf cells (left side), × 175; **5.** upper laminal cells at right margin, × 350; **6.** cells at leaf apex, × 175.(*Taylor* sub *Sim 10281*.)

Distichophyllum mniifolium *(Hornsch.) Sim* var. **taylorii** *(Sim) Magill*, stat. nov. Type: South Africa, Cape Prov., Wilderness, George, *Taylor s.n.* (sub *Sim 10281*, PRE, holo.!).

Distichophyllum taylorii Sim, Bryo. S. Afr. 441 (1926).

See species description and key. Fig. 170.

Endemic to the southern Cape area. Map 238.

Voucher: type only.

The specimen differs from the typical variety by the characters used in the key (cf. Sim 1926: 441), although this cell size difference is magnified by the more regular cell shape of var. *taylorii*. The leaves of the type are short for the species, the border is somewhat stronger and the upper margins are practically entire. Since each of these latter character states is also found in specimens of var. *mniifolium*, additional specimens of var. *taylorii* are needed to assess its status properly.

7. HYPOPTERYGIUM

Hypopterygium *Brid.*, Bryol. univ. 2: 709 (1827); Sim, Bryo. S. Afr. 445 (1926); Broth. in Natürl. PflFam., edn 2, 11: 273 (1925). Type species: not designated.

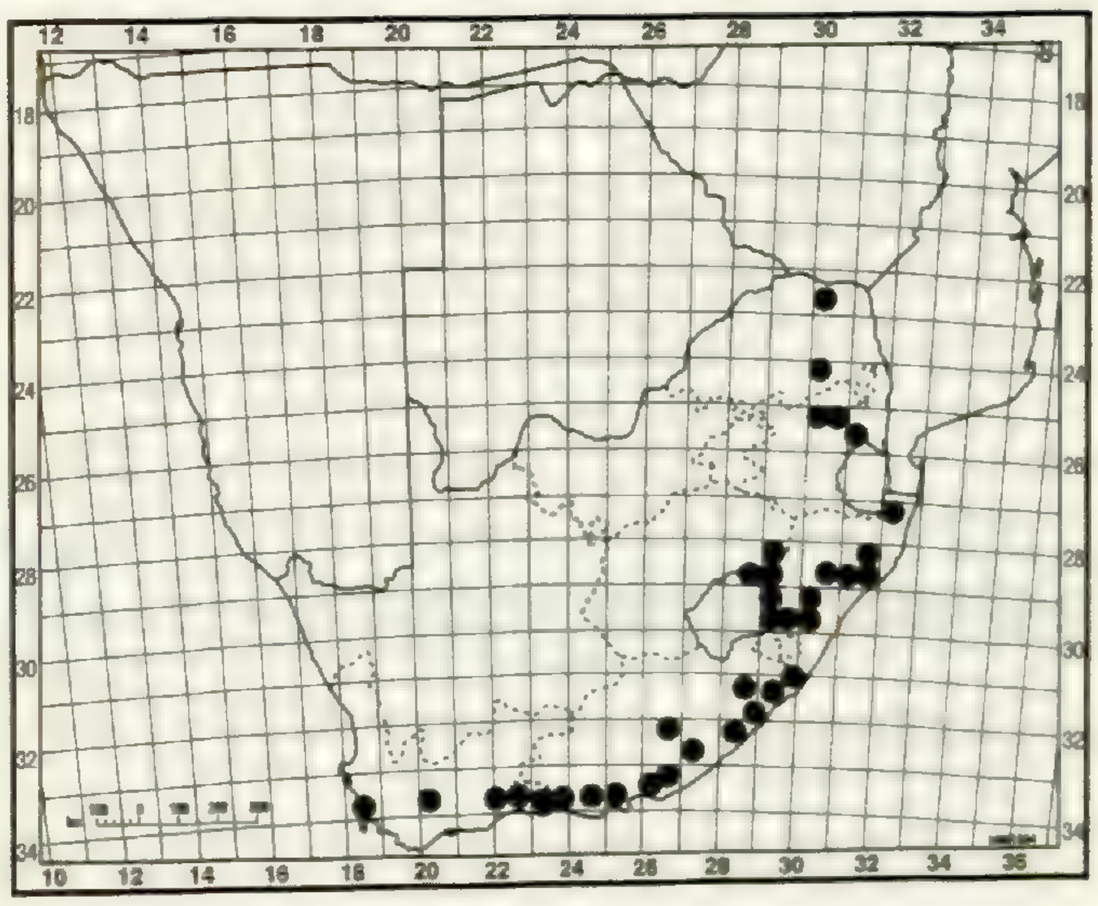
Plants small to large, scattered, light green; terricolous, saxicolous or corticolous. *Primary stems* long-creeping; secondary stems erect, heterophyllous, flabellate above naked stipe. *Leaves* dimorphic, in three ranks; lateral ranks larger, spreading; amphigastria small, rounded and apiculate; margins generally bordered, plane, entire to dentate. *Costa* variable, single or forked, short or extending to midleaf or above. *Laminal cells* rhomboidal; border cells elongate.

Autoicous. *Seta* elongate, smooth. *Capsule* horizontal. *Peristome* double, incomplete; cilia present. *Operculum* rostrate. *Calyptra* cucullate. *Spores* small.

A genus of 59 species found in tropical America, Africa and Asia. Ten species are known from Africa. *H. laricinum* and *H. viridissimum* C. Müll., the two most widely distributed species, are known from western and eastern Africa and Madagascar. The genus is sometimes placed with the other dimorphic-leaved genus, i.e. *Lopidium*, in a separate family, Hypopterygiaceae.

Hypopterygium laricinum *(Hook.) Brid.*, Bryol. univ. 2: 714 (1827); Sim, Bryo. S. Afr. 446 (1926); Broth. in Natürl. PflFam., edn 2, 11: 275 (1925). Syntypes: Prom. bon. spei, *D. Menzies 75* (BM); in jugis andian regione temperata, *Humboldt & Bonpland s.n.*

Hypnum laricinum Hook., Musci exot. 1: 35 (1818).



MAP 240.—**Hypopterygium laricinum**

Plants small to large, scattered, gregarious, green to grey-green; terricolous, saxicolous or corticolous. *Primary stems* long-creeping, frequently tomentose; secondary stem erect, 20–40 mm long; branching regular, flabellate above stipe; in section round, central strand large, inner cortical cells thin-walled, large, hyaline, in 5 or 6 rows, outer cortical cells smaller, weakly thick-walled, in 2 or 3 rows, epidermis of enlarged thin-walled cells, hyaline. *Leaves* dimorphic, flattened, widespreading wet, spreading and weakly crisped dry; stem leaves asymmetrical, broadly ovate in lateral ranks, 1.8–2.2 mm long; obtuse and apiculate or cuspidate; rounded at base; margins plane, entire, unistratose, bordered by elongated cells, hyaline; amphigastria orbicular or broader than long, 1.0–1.2 mm long; branch leaves asymmetrical, broadly ovate, 1.2–1.5 mm long; obtuse and apiculate or cuspidate; rounded at base; margins plane, serrate, unistratose, bordered by elongated cells, hyaline; branch amphigastria orbicular, to 1 mm long, margins entire. *Costa* variable, single, short or extending to midleaf, sometimes extending to apex, frequently forked, displaced proximally in lateral leaves; ventral and dorsal surfaces smooth, cells elongate; in section flattened, 3 rows of small, unthickened cells. *Upper laminal cells* rhomboidal, homogeneous, 45–75 µm long, 20–30 µm wide, walls thin, weakly pitted, smooth; basal cells not differentiated or some rectangular cells at attachment, walls thin, weakly pitted, smooth; alar cells not differentiated.

Autoicous. *Perigonia* on stem, gemmate; perigonial leaves ovate-acuminate, 1.5 mm long. *Perichaetia* obvious, green; perichaetial leaves ovate to oblong, 1.5–2.0 mm long; acuminate; leaf cells fusiform, pitted. *Seta* 8–10 mm long, brown, smooth. *Capsule* exserted, horizontal to nodding, short-cylindrical, 1.5 mm long, smooth, brown; neck shorter than urn; exothecial cells quadrate to hexagonal, walls thin, cells at mouth quadrate, neck cells quadrate, annulus present; stomata raised, phaneropore. *Peristome* double, yellow; exostome teeth fragile, oblong, weakly striate, with median zigzag line, 350 µm high (old and broken); endostome segments linear above low basal membrane, shorter than teeth, smooth; cilia 1–3, shorter than segments. *Operculum* long-rostrate, 1 mm long. *Calyptra* cucullate, smooth. *Spores* rounded, 10–15 µm, granulate, yellowish. Fig. 171: 1–13.

Hypopterygium laricinum is found in Central and South America, eastern and southern Africa, Gabon and the East and West African islands. In the *Flora* area, it is collected on soil, rocks or at the base of trees in forests of the northern and eastern Transvaal regions, Zululand, KwaZulu-Natal and the eastern, southern and southwestern Cape areas. Map 240.

Vouchers: *Glen 3324; Magill 5105, 5451, 6212; Schelpe 7890; Van Rooy 2103.*

This species is recognized by its erect, flabellate secondary stems and dimorphic leaves. It could be confused with *Lopidium penniforme* which also has erect secondary stems, dimorphic leaves and grows in similar habitats; however, the amphigastria of *L. penniforme* are lanceolate

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to ovate-acuminate while those of *H. laricinum* are orbicular. In addition, the secondary stems of *L. penniforme* are pinnately branched.

A few plants have short (0.2–1.0 mm), brown 'rhizoids' in small tufts on the stems and branches. They are longer than the gemmae found on *Lopidium*, have somewhat longer cells, are weakly granulate and occasionally have short lateral buds. Although each of these characters points toward rhizoids rather than gemmae, their position on an erect stem seems unusual.

8. LOPIDIUM

Lopidium *Hook. f. & Wilson*, Fl. nov.-zel. 2: 119 (1855); Broth. in Natürl. PflFam., edn 2, 11: 271 (1925). Lectotype species: *L. concinnum* (Hook.) Wilson, fide Dixon (1927).

Plants medium-sized to large, scattered, light green; saxicolous or corticolous. *Primary stems* long-creeping, tomentose; secondary stems erect, heterophyllous, pinnately branched above naked stipe; central strand small or absent. *Leaves* dimorphic, in three ranks; lateral ranks larger, widely spreading; amphigastria smaller and narrower; margins plane, serrulate, bordered by elongated cells. *Costa* short-excurrent. *Laminal cells* rhomboidal.

Seta short, rough. *Capsule* small, ± erect; annulus present. *Peristome* double, incomplete; cilia absent. *Operculum* rostrate. *Spores* small.

Lopidium contains ± 19 species found in the southern hemisphere. Four species are known from Africa or the East African islands, only one of which extends into the *Flora* area. The genus has been placed by some authors in the family Hypopterygiaceae.

Lopidium penniforme *(Brid.) Fleisch.*, Musc. Buitenzorg 3: 1073 (1908); Broth. in Natürl. PflFam., edn 2, 11: 271 (1925). Type: Prom. bon. spei, *Thunberg s.n.*

Hypnum penniforme ('*pennaeforme*') Thunb. ex Brid., Muscol. recent. suppl. 2: 96 (1812). *Hypopterygium penniforme* ('*pennaeforme*') (Brid.) Brid., Bryol. univ. 2: 717 (1827); Sim, Bryo. S. Afr. 446 (1926).

Hypopterygium polythrix Dix. in Kongel. Norske Vidensk. Selsk. Skr. (Trondheim) 1932, 4: 15 (1932). Type: South Africa, Natal, Zululand, Eshowe, in indigenous forest, 22 Aug. 1929, *Höeg 127* (BM, lecto.!, selected here).

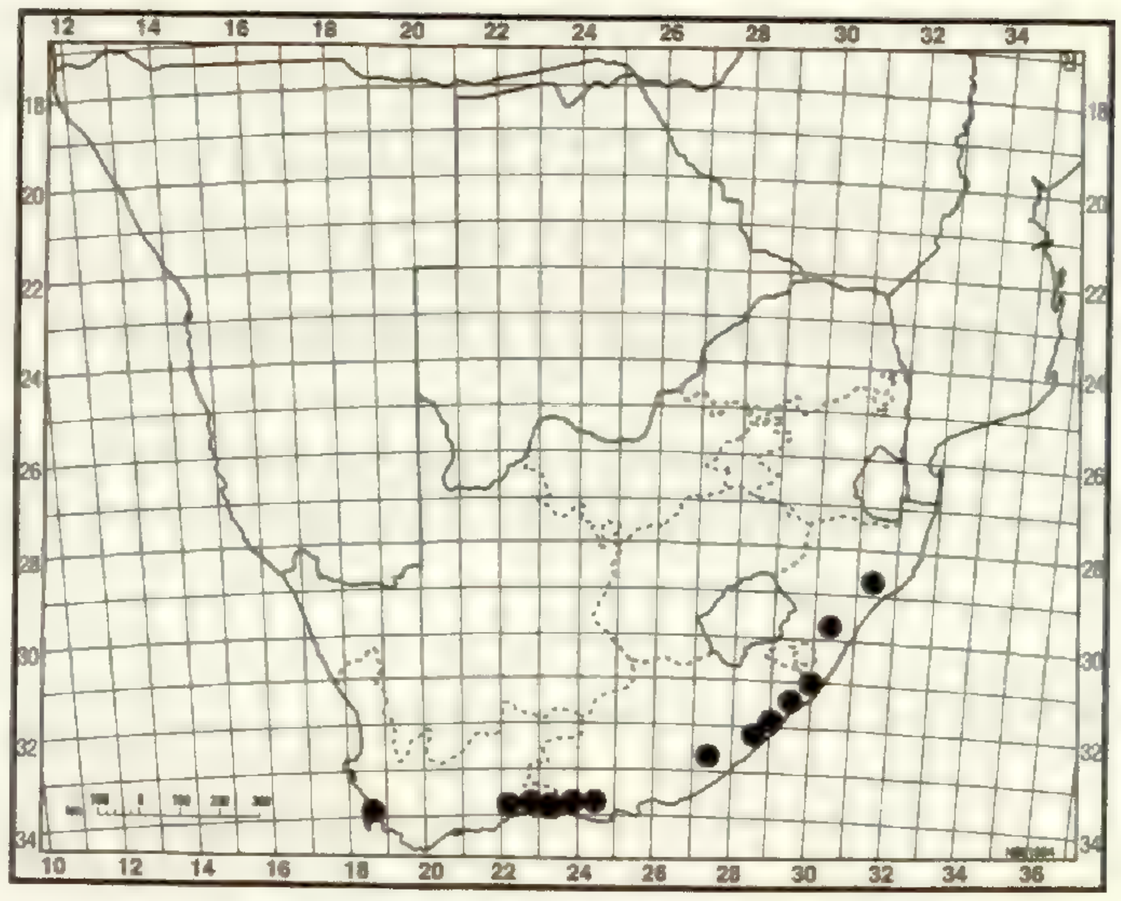
Plants medium-sized to large, scattered and gregarious, glaucous green; saxicolous or corticolous. *Primary stems* long-creeping; secondary stem erect, 10–35 mm long, branching regular, pinnate above stipe; in section round, central strand absent but with central cavity, inner cortical cells thin-walled, hyaline, in 8–12 rows, outer cortical cells larger, thick-walled, brown, in 3–6 rows, epidermis absent. *Leaves* in ranks, dimorphic, widespreading wet, contorted dry, asymmetrical; stem leaves ovate or panduriform, 1.8–2.2 mm long; obtuse and cuspidate; rounded at base; margins plane, serrulate throughout but stronger above, unistratose, bordered by elongated hyaline cells; amphigastria broadly ovate, abruptly narrowed, 1.2–1.6 mm long; branch leaves lanceolate to elliptical, 1.2–1.5 mm long; acute

FIG. 171.—**Hypopterygium laricinum** (1–13): **1.** habit (dry), × 1; **2.** part of secondary stem and branches (wet), × 5; **3.** stem in cross section, × 175; **4.** leaf, × 35; **5.** amphigastrium, × 35; **6.** part of leaf in cross section, × 175; **7.** basal leaf cells (right side), × 175; **8.** cells at leaf apex, × 175; **9.** perichaetial leaf, × 35; **10.** part of capsule mouth showing cells and peristome, × 70; **11.** operculum, × 18; **12.** calyptra, × 18; **13.** spore, × 700. **Lopidium penniforme** (14–25): **14.** habit (dry), × 1; **15.** part of secondary stem and branch (wet), × 10; **16.** part of stem in cross section, × 175; **17.** secondary stem leaf, × 35; **18.** branch leaf, × 35; **19.** branch amphigastrium, × 35; **20.** secondary stem amphigastrium, × 35; **21.** secondary stem leaf in cross section, × 175; **22.** basal leaf cells (right side), × 175; **23.** branch leaf cells at left margin, × 350; **24.** cells at branch leaf apex, × 175; **25.** gemmae, × 175. (1, 2 & 12, *Lewis PRE-CH12210*; 3 & 6, *Berry 49*; 4, 5, 7 & 8, *Sim 9430*; 9, *Crosby 8041*; 10, 11 & 13, *Von Breitenbach 90*; 14–25, *Magill 6008*.)

and cuspidate; rounded at base; margins plane, serrulate throughout, somewhat stronger above, unistratose, bordered by elongated hyaline cells; amphigastria lanceolate to ovate-acuminate, 0.6–1.0 mm long. *Costa* single, shortly excurrent, displaced proximally in lateral leaves; ventral and dorsal surfaces smooth, cells elongate; in section elliptical, cells in 3 rows, smaller, incrassate. *Upper laminal cells* rounded quadrate to rectangular or transversely rectangular, homogeneous, 10–15 µm long, in amphigastria 5–7 µm long, walls incrassate to somewhat collenchymatous, smooth; basal cells not differentiated, walls thickened and pitted, smooth; alar cells not differentiated. *Gemmae* on stem and branches, in small groups, cylindrical, 200–400 µm, brown, papillose.

Sporophyte not seen; see Sim (1926: 447). Fig. 171: 14–25.

Known from Tanzania, Zimbabwe and South Africa, *L. penniforme* is found on the base of trees, roots and moist rocks in forests of the southern, southwestern and eastern Cape regions, KwaZulu-Natal and Zululand. Map 241.



MAP 241.—**Lopidium penniforme**

Vouchers: *Magill 6021; Russell 2684; Stirton 9663; Van Rooy 2125.*

Lopidium penniforme can be identified by its erect, pinnate secondary stems with dimorphic leaves and narrow amphigastria. Although it is similar to *Hypopterygium laricinum*, the two species are easily separated by the shape of their amphigastria and branching patterns (see p. 615).

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APPENDIX

PLAN OF *FLORA OF SOUTHERN AFRICA*

Cryptogam volumes will in future not be numbered, but will be known by the name of the group they cover. The number assigned to the volume on Charophyta therefore becomes redundant. Occasional contributions to the *Flora* are published in *Bothalia* under the title *FSA contributions*.

Exotic families are marked with an asterisk.

Published volumes and parts are shown in bold.

INTRODUCTORY VOLUMES

The genera of southern African flowering plants
Vol. 1: **Dicotyledons** (1975)
Vol. 2: **Monocotyledons** (1976)

Botanical exploration of southern Africa (1981)

CRYPTOGAM VOLUMES

Charophyta (as Vol. 9 in 1978)

Bryophyta: Part 1: Musci: Fascicle 1: **Sphagnaceae–Grimmiaceae** (1981)
Fascicle 2: **Gigaspermaceae–Bartramiaceae** (1987)
Fascicle 3: **Erpodiaceae–Hookeriaceae** (1998)
Fascicle 4: Fabroniaceae–Polytrichaceae

Hepatophyta
Anthocerotophyta

Pteridophyta (1986)

FLOWERING PLANTS VOLUMES

Vol. 1 : **Stangeriaceae, Zamiaceae, Podocarpaceae, Pinaceae*, Cupressaceae, Welwitschiaceae, Typhaceae, Zosteraceae, Potamogetonaceae, Ruppiaceae, Zannichelliaceae, Najadaceae, Aponogetonaceae, Juncaginaceae, Alismataceae, Hydrocharitaceae** (1966)

Vol. 2 : Poaceae

Vol. 3 : Cyperaceae, Arecaceae, Araceae, Lemnaceae, Flagellariaceae

Vol. 4 : Part 1: Restionaceae
Part 2: **Xyridaceae, Eriocaulaceae, Commelinaceae, Pontederiaceae, Juncaceae** (1985)

Vol. 5 : Part 1: Colchicaceae, Eriospermaceae, Asphodelaceae (***Chortolirion***, 1995 in *Bothalia* 25: 31–33; ***Poellnitzia***, 1995 in *Bothalia* 25: 35–36)
Part 2: Alliaceae, Liliaceae*, Hyacinthaceae, **Agavaceae** (1996 in *Bothalia* 26: 31–35)
Part 3: **Dracaenaceae, Asparagaceae, Luzuriagaceae, Smilacaceae** (1992)

Vol. 6 : Haemodoraceae, Amaryllidaceae, Hypoxidaceae, Tecophilaeaceae, Velloziaceae, Dioscoreaceae

Vol. 7 : Iridaceae: Part 1: Nivenioideae, Iridoideae
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Fascicle 2: ***Syringodea, Romulea*** (1983)

Vol. 8 : Musaceae, Strelitziaceae, Zingiberaceae, Cannaceae*, Burmanniaceae, Orchidaceae (***Holothrix***, 1996 in *Bothalia* 26: 125–140)

Vol. 9 : Casuarinaceae*, Piperaceae, Salicaceae, Myricaceae, Fagaceae*, Ulmaceae, Moraceae, Cannabaceae*, Urticaceae, Proteaceae

Vol. 10: Part 1: **Loranthaceae, Viscaceae** (1979), Santalaceae, Grubbiaceae, Opiliaceae, Olacaceae, Balanophoraceae, Aristolochiaceae, Rafflesiaceae, Hydnoraceae, Polygonaceae, Chenopodiaceae, Amaranthaceae, Nyctaginaceae

Vol. 11: Phytolaccaceae, Aizoaceae, Mesembryanthemaceae

Vol. 12: Portulacaceae, Basellaceae, Caryophyllaceae, Illecebraceae, Cabombaceae, Nymphaeaceae, **Ceratophyllaceae** (1997 in *Bothalia* 27: 125–128), Ranunculaceae, Menispermaceae, Annonaceae, Trimeniaceae, Lauraceae, Hernandiaceae, Papaveraceae, Fumariaceae

Vol. 13: **Brassicaceae, Capparaceae, Resedaceae, Moringaceae, Droseraceae, Roridulaceae, Podostemaceae, Hydrostachyaceae** (1970)

Vol. 14: **Crassulaceae** (1985)

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Vol. 18: Part 1: Linaceae, Erythroxylaceae, Zygophyllaceae, Balanitaceae
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Part 3: **Simaroubaceae, Burseraceae, Ptaeroxylaceae, Meliaceae (Aitoniaceae), Malpighiaceae** (1986)

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Part 2: Euphorbiaceae, Callitrichaceae, **Buxaceae** (1996 in *Bothalia* 26: 37–40)
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Vol. 21: Part 1: **Tiliaceae** (1984)
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Vol. 22: **Ochnaceae, Clusiaceae, Elatinaceae, Frankeniaceae, Tamaricaceae, Canellaceae, Violaceae, Flacourtiaceae, Turneraceae, Passifloraceae, Achariaceae, Loasaceae, Begoniaceae, Cactaceae** (1976)

Vol. 23: Geissolomaceae, Penaeaceae, Oliniaceae, Thymelaeaceae, Lythraceae, Lecythidaceae

Vol. 24: Rhizophoraceae, Combretaceae, Myrtaceae, Melastomataceae, **Onagraceae** (1997 in *Bothalia* 27: 149–165), Trapaceae, Haloragaceae, Gunneraceae, Araliaceae, Apiaceae, Cornaceae

Vol. 25: Ericaceae

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FSA CONTRIBUTIONS IN *BOTHALIA*

FSA contributions 1: Aquifoliaceae. S. ANDREWS. 1994. *Bothalia* 24: 163–166.
FSA contributions 2: Asphodelaceae/Aloaceae, 1029010 *Chortolirion*. G.F. SMITH. 1995. *Bothalia* 25: 31–33.
FSA contributions 3: Asphodelaceae/Aloaceae, 1028010 *Poellnitzia*. G.F. SMITH. 1995. *Bothalia* 25: 35, 36.
FSA contributions 4: Agavaceae. G.F. SMITH & M. MÖSSMER. 1996. *Bothalia* 26: 31–35.
FSA contributions 5: Buxaceae. H.F. GLEN. 1996. *Bothalia* 26: 37–40.
FSA contributions 6: Orchidaceae: *Holothrix*. K.L. IMMELMAN. 1996. *Bothalia* 26: 125–140.
FSA contributions 7: Verbenaceae: *Vitex*. C.L. BREDENKAMP & D.J. BOTHA. 1996. *Bothalia* 26: 141–151.
FSA contributions 8: Ceratophyllaceae. C.M. WILMOT-DEAR. 1997. *Bothalia* 27: 125–128.
FSA contributions 9: Onagraceae. P. GOLDBLATT & P.H. RAVEN. 1997. *Bothalia* 27: 149–165.

ALPHABETICAL ARRANGEMENT OF TAXA LISTED AS 'PUBLISHED' IN PLAN OF *FLORA OF SOUTHERN AFRICA*

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